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The
ILLUMINATING ENGINEER

THE JOURNAL OF GOOD LIGHTING

Edited by

J. STEWART DOW

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Principal Contents:

Airway Lighting

THE navigator of the air, like the mariner at sea, has to travel vast distances under varied climatic conditions. He is grateful for lighthouses and beacons where they exist, but in traversing many wild areas he must necessarily rely on his skill and on such aids as nature can afford.

Nevertheless, in a fully developed country such as ours, there is no reason why the use of artificial light as an aid to navigation should not be exploited to the full. Night flying, both for regular passenger service and by private persons, tends to become more and more usual.

The technical problems are fully understood. Mr. H. N. Green, in his recent paper before the Illuminating Engineering Society (See pp. 146-156), showed that ample equipment for the lighting of airways and aerodromes has been devised.

The main problem can be put in a nutshell—"*Who Is To Pay For It?*"

We offer the suggestion that the State should undertake the supervision, and, if necessary, the payment. Let us have uniform methods and practice and avoid the anomalies and diversities that complicate the problem of illuminating highways on land.

Literature on Illumination in Libraries

A complete scheme, illustrating the application of the Dewey Decimal system of classification to illuminating engineering, was recently presented in the Transaction of the Illuminating Engineering Society (U.S.A.). How far such a scheme is applicable to systems in British libraries remains to be seen. But it seems certain that in the chief scientific and technical libraries much data of value to illuminating engineers is classified in such a way that its existence may easily be overlooked. One would like to know that a satisfactory classification of literature on photometry and illumination, including all the aspects which lighting experts would desire, was available for reference on demand in at least one leading technical library in London. Equally valuable, though perhaps less readily secured in existing libraries, would be a section in which all books relating to lighting were collected, so as to be ready for consultation on the spot. Whilst at the moment the resources of the Illuminating Engineering Society would hardly be equal to the equipment and maintenance of such a library, there is much to be said for the suggestion that it should at once commence the assembly of a nucleus of suitable books—especially those of a kind likely to become less easily obtainable in the future.

High Illuminations: Their Influence on Contrast and Perspective

It is a familiar fact that the greater contrast available from a lantern slide, as compared with a photograph, gives much more "life" to a picture. Similarly a well executed "positive" of a lighting installation, backed by diffusing glass and illuminated from behind is much more impressive than a photographic print illuminated from in front—on which the possible range in brightness probably does not exceed 20 to 1. It has, however, also been suggested that a very high illumination does, in itself, create a certain sense of "life" and animation. In support of this view attention has been called to some of the very effective displays of photographs recently arranged in the exhibition area at Charing Cross (Underground) station, where an exceptionally high illumination is usually available. There is no doubt that many of these photographs showed to great advantage, and that in some cases there seemed to be a degree of life, animation, and perspective that one ordinarily lacks. The effect seems to be most in evidence when the impression of gazing through a window is given. One wonders whether there is a physiological explanation or whether it is merely a matter of mental association.

Combination Fittings for Electric Filament and Discharge Lamps

The note on this subject in our last issue has brought us some interesting correspondence, confirming the view that a casual interruption of the supply to these combination fittings is unlikely to cause any material delay in the starting up of the electric discharge lamps. Mr. J. J. Wells tells us that combination lamps in the Camden-road, London, were repeatedly switched off during experimental work. The discharge lamps invariably started up again after the usual interval for cooling down, though the filament lamps (only about 1½ inches away), of course, lighted up instantly when the current was switched on. In Croydon, where, Mr. F. N. Rendell-Baker states, some 300 combination units, covering nearly ten miles of streets, have been installed during the past two years, experience has been similar. In general one 400-w. discharge lamp surrounded by three 200-w. filament lamps is used; or, in the narrower thoroughfares, one 250-w. discharge lamp with three 150-w. filament lamps. After the circuit has been momentarily broken, four minutes elapse before the mercury lamp starts up again, the filament lamps lighting up immediately. As the corresponding time for the mercury lamps alone to light up is 3½ minutes. the difference is inappreciable. Mr. Rendell-Baker states that this new form of lighting is proving very popular, and petitions desiring its use in shopping areas have been received.

E.L.M.A. 31st Illumination Design Course

Special interest attaches to the forthcoming E.L.M.A. Illumination Design Course, which opens on May 13 and terminates on the 17th. Apart from the interest of the course itself, it will afford an opportunity for those from the provinces to see the Jubilee illuminations. The reconstructed premises of the Bureau, in which many new demonstrations have been staged, will also be on view. The subject-matter of the course follows familiar lines, though we notice that special attention is being devoted to architectural lighting, and that Mr. W. J. Jones is lecturing on "The New Science of Seeing," a phrase with which Dr. M. Luckiesh has made us familiar. There are eighteen items on the programme, in which other familiar names appear, though it is a feature of the Bureau's method that new lecturers are continually being brought forward. Floodlighting, and the lighting of homes, shops, and factories are to be treated in addresses, and visits to lighting installations are being arranged. Those desirous of attending the course should apply at once to the Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

The Illuminating Engineering Society

Notes on Recent Meetings & Events

Meeting in London, April 9.

A MEETING of the Illuminating Engineering Society took place in the Lecture Theatre of the Institution of Mechanical Engineers (Storey's Gate, Westminster, S.W.1) on Tuesday, April 9. Members assembled for light refreshments at 6.30 p.m., and the chair was taken by the President (Mr. H. Hepworth Thompson) at 7.0 p.m.

The minutes of the last meeting having been taken as read, the Hon. Secretary read out the names of applicants for membership, which are appended. The names of those presented at the last meeting on March 12* were read again, and these gentlemen were formally declared members of the Society.

The President then called upon the following authors to present their contributions: Mr. P. D. Oakley on "A Works' Photo-electric Method for the Photometry of Electric Discharge Lamps"; Mr. R. A. Holmes on "A Simple System for Recording and Displaying Measurements of Illumination"; Mr. H. S. Barlow on "The Use of Scale Models in Illuminating Engineering"; and Mr. H. Lingard on "Practical Considerations in Architectural Lighting."

These papers, which were presented in Abstract, were illustrated by numerous lantern slides and demonstrations—the series of slides shown by Mr. Barlow illustrating the use of models being particularly comprehensive. An interesting discussion followed, in which Mr. H. Buckley, Mr. A. Cunnington, Mr. E. L. Damant, Lieut.-Col. K. Edgcumbe, Dr. S. English, Mr. W. J. Jones, Dr. J. W. T. Walsh, and Mr. G. H. Wilson took part. After the authors had briefly replied a cordial vote of thanks to them for these interesting papers terminated the proceedings.

* Illum. Eng., April, 1935, p. 107.

Applicants for Membership.

SUSTAINING MEMBER:—

Automatic Electric Co., Ltd. ....Melbourne House, Aldwych, LONDON, W.C.2.
(*Representative*:—Mr. Frederick R. Baldock.)

CORPORATE MEMBERS:—

Bentham, F. R. ....Gresby, Pebworth Road, Watford Road, Harrow, MDDSX.

Hulcoop, F. A. ....212, Norbury Crescent, Norbury, LONDON, S.W.16.

Stretton, T. ....Condordia Electric Safety Lamp Co., Thor Works, Tredegar Street, CARDIFF.

COUNTRY MEMBERS:—

Castle, E. A. ....47, Dawson Street, DUBLIN.

Davey, W. J. G. ....301, Flaxley Road, Yardley, BIRMINGHAM.

Houston, R. E. ....Fletcher, Houston & Co., Portfield Works, Dudley Port, Tipton, STAFFS.

Pathe, K. M. ....Jacababad Electric Supply, Jacababad (Sind), INDIA.

AFFILIATED STUDENTS:—

Branson - Griffiths, W. E. ....29, Rowsley Avenue, Hendon, LONDON, N.W.4.

Harris, J. B. ....32B, Lavender Sweep, LONDON, S.W.11.

Forthcoming Events.

May 14. **Annual Meeting.** After the transaction of formal business an **Address** by PROFESSOR DR. M. PIRANI (Berlin). *(Meeting of the Illuminating Engineering Society to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.)*; **6.30 p.m.**

May 31. MR. S. B. LANGLANDS on **Street Lighting and its Relation to the Safety of the Roads** *(National Safety Congress; Joint Session of the Illuminating Engineering Society and the Association of Public Lighting Engineers, Park Lane Hotel, London)*; **2.30 p.m.**

Recent Developments in Airway and Aerodrome Lighting

By H. N. GREEN

(Paper read at the Joint Meeting of the Illuminating Engineering Society and the Royal Aeronautical Society held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, at 6.30 p.m., on Tuesday, March 12, 1935.)

Introduction.

In certain branches of illuminating engineering lighting units have been designed which completely satisfy recognised and unchanging requirements.

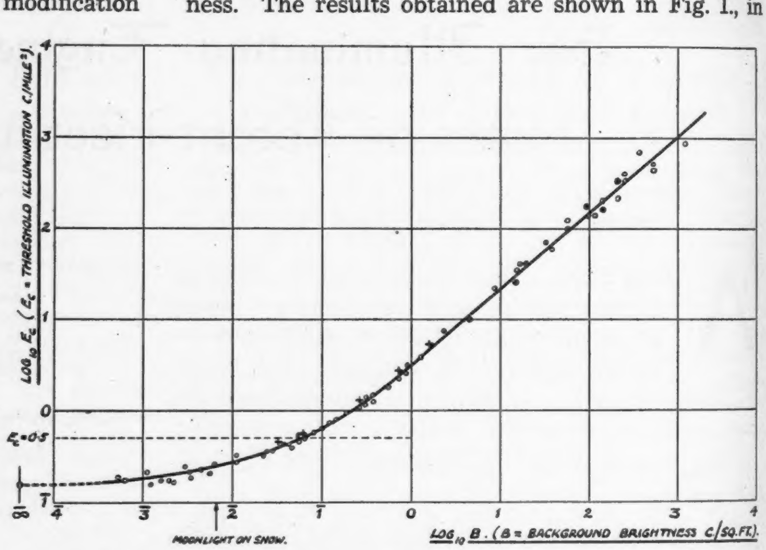
Aviation lighting is not one of these branches. The requirements of many of the lights are not precisely known, and, in addition, are liable to modification owing to improvements in the technique of night flying. Design has reached a stage at which the obvious requirements are met, and further progress primarily depends on the attainment of a clearer understanding of what the various lights should do and how they are used. As developments in the theory as well as the apparatus of aviation lighting will be described the general question of the visibility of light signals must first be considered.

A light is said to be visible when the illumination it produces on the eye exceeds a certain minimum known as the threshold illumination. This quantity, which can conveniently be expressed in terms of the illumination given by one candle at a distance of one mile, varies considerably with the observer's eyesight, physical condition, dark adaptation and direction of vision. It is also influenced by the brightness of the background against which the light is seen.

The practical threshold for the recognition of a light signal from the air will obviously be higher than the threshold which would be obtained under laboratory conditions of measurement. Tests have shown that a light of 0.5 candle at one mile can be located, without undue difficulty or delay, by observers wearing goggles and subjected to local lighting equivalent to that in an aeroplane cockpit.*

This value of 0.5-mile candle would be modified if it were customary to view lights obliquely; that is, looking in a direction a few degrees away from the direction of the light. Recognition of white light in darkness is easier when looking slightly away from it (parafoveal vision), the threshold illumination being about one-fifth of that required when it is viewed directly (foveal vision).† Thus a light seen obliquely can be identified when its conspicuity is in the order of 0.1-mile candles. Aviation lights are generally picked up by parafoveal vision; but, since every such light has a specific character, the observer will not be satisfied without looking directly at a light to ascertain either its colour or flash period. This condition entails the adoption of the higher value of 0.5-mile candle.

The effect of background brightness has been investigated by measuring the threshold values for a point source against backgrounds of which the brightness could be adjusted to any value between the highest brightness occurring in daylight and complete darkness. The results obtained are shown in Fig. I., in



THRESHOLD VALUES FOR A STEADY LIGHT AT DIFFERENT BACKGROUND BRIGHTNESSES. FOVEAL VISION.

(Royal Air Force Official—Crown Copyright Reserved).

Fig. I.

which the log of the threshold illumination is plotted against the log of the background brightness.

The brightest background which can be experienced at night is given by full moonlight on snow and is approximately 7×10^{-3} candles per square foot.‡ It will be seen from the curve in Fig. I. that the threshold illumination required against this background is half that adopted as a practical standard, while that required in complete darkness is one-third. It is thus apparent that the effect of background brightness at night is small and, in view of the margin allowed by a practical threshold of 0.5-mile candle, can safely be neglected.

The apparent intensity of a distant light is diminished by atmospheric absorption and scattering. According to Beer's law, when the atmospheric transmission is t per unit distance, the observed intensity I′ of a distant light of initial intensity I is given by—

$$I' = It^d \quad \text{......(i)}$$

Since the conspicuity of a light, which will be denoted by the symbol E_c, is dependent on the illumination it produces—

$$E_c = \frac{I'}{d^2} \quad \text{......(ii)}$$

and, combining (i) and (ii) $E_c = \dfrac{It^d}{d^2}$ ......(iii)

* Toulmin Smith and Green. Aircraft Engineering, January, 1931, 3, p. 12.

† Walsh. Photometry, pp. 69, 70.

‡ Langmuir and Westendorp. Physics, November, 1921, I., 5, p. 276.

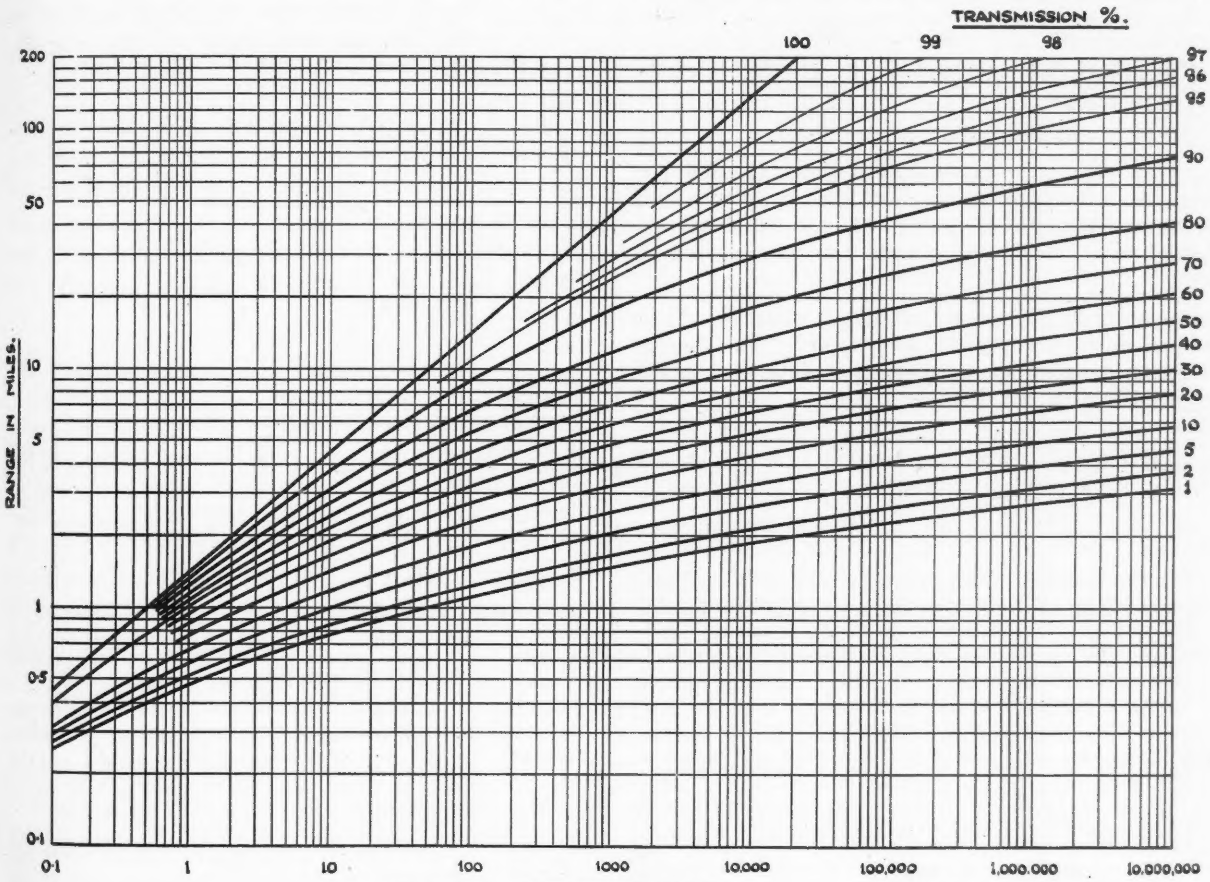
This equation is generally applicable to white lights, and when used to determine the conspicuity of aviation lights under night flying conditions, needs no modification for either direction of vision or background brightness.

As the solution of equation (iii) is not easy for the range of a light of given intensity, the curves in Fig. II. have been prepared, from which the range for any intensity from 0.1 to 10^7 candles can be obtained for atmospheric transmissions between 1 and 100 per cent. per mile.

When the character of a light consists of short flashes it will not be seen at such long ranges as are

weather. These beacons are perhaps the most important lights used in aviation; they are also the most difficult for which to state the requirements. It is now generally agreed that the most useful beacon is the single-flash type, in which the revolving optical system emits one or more beams, the maximum intensity being directed nearly horizontally. There is as yet no agreement on what this maximum intensity should be, how the light should be distributed in the beam, how long the flash should last or what time should elapse between flashes.

The intensity of airway beacons must obviously be related to the distance apart at which they will be



(Royal Air Force Official—Crown Copyright Reserved)

Fig. II.

indicated by Fig. II., the result of flashing being to diminish the apparent intensity. The amount by which the intensity appears to decrease depends on the duration of the flash and the conspicuity of the light.* A light which is faintly visible may entirely disappear if it is flashed, whereas a light which can be seen easily will not become noticeably less visible if given the same flash period.

For a conspicuity of 0.5 mile candle, the apparent intensity I′ of a light of initial intensity I and flash period T is given by the empirical formula—

$$I' = I \cdot \frac{T}{0.1+T} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(iv)}$$

Following these introductory remarks on the visibility of light signals, the practical application of the data to design problems will be considered.

Airway Beacons.

An airway beacon is a light placed on or near an airway to indicate the route in clear weather, and to provide a visual check on navigation in bad

* Toulmin Smith and Green. "Illum. Eng.," 1934, XXVI., p 304.

spaced on a route. In Great Britain this spacing is subject to the principle that a pilot flying from one beacon towards the next in the worst atmospheric conditions under which night flying is normally carried out and deviating not more than 5 degrees from the track shall always pass within visible range of this next beacon. This atmospheric condition corresponds to a transmission of about 2 per cent. per mile.

This method of spacing permits the employment of low-power beacons at short intervals or high-intensity beacons at relatively long intervals apart, and there is a considerable difference of opinion as to which system is preferable. It is of interest to examine the results obtained by these alternative arrangements, especially as both are actually in operation.

It is assumed that beacons of intensity I are placed along a route on which the average flying height at night is h. The range D of each beacon when atmospheric transmission is t can be either calculated from equation (iii) or obtained from the curves in Fig. II. If the light intensity is the same in all direc-

tions* then a beacon will be visible, on a horizontal plane at a height h above ground level, within a circle of which the centre is vertically over the beacon and of which the radius is $\sqrt{D^2-h^2}$. (Refer Fig. III.)

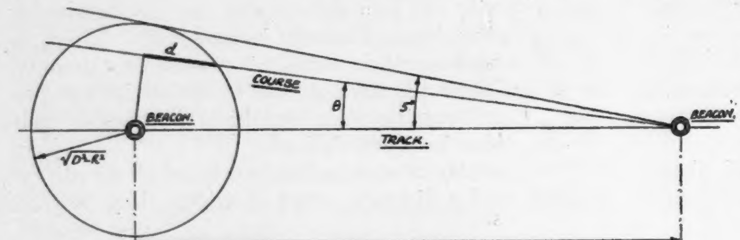


Fig. III.

The appropriate spacing S for the beacons is, therefore, given by—

$$S = \frac{\sqrt{D^2-h^2}}{\sin 5^\circ} \quad \text{.......................(v)}$$

If, due to errors in navigation, the angular deviation from the true course is θ°, the beacon would be passed at a distance S sin θ, and the total distance over which it would remain visible is $2\sqrt{(D^2-h^2)-(S\sin\theta)^2}$.

As, however, it is improbable that a beacon will be picked up once the pilot has passed it, the effective distance d, in which the beacon is both visible and before the observer, is given by—

$$d = \sqrt{(D^2-h^2)-(S\sin\theta)^2} \quad \text{......(vi)}$$

and, if the velocity of the aircraft is v, the time T available for picking up the beacon is given by—

$$T = \frac{\sqrt{(D^2-h^2)-(S\sin\theta)^2}}{v} \quad \text{........... (vii)}$$

Curves derived from equations (v) and (vii) are shown in Fig. IV., on the assumption that θ = 4° 30′,

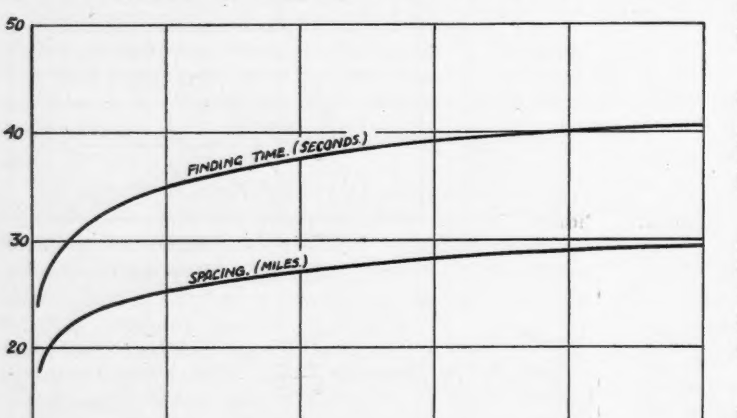


Fig. IV.

h = 3,000 feet, t = 2% per mile and v = 100 miles/hour. It will be seen that any increase in the intensity and spacing distance of beacons produces an increase in the finding time, so that, theoretically, there is no upper limit to the intensity which can usefully be employed. The practical limit, as indicated by the curve connecting finding time and intensity, is in the order of 50,000 candles.

Although it has been shown that the finding time increases with intensity, the argument is incomplete without proving that the more powerful beacons are at least as conspicuous as their less powerful competitors during the time they are visible. It is not at once obvious that the powerful lights at long range will be easier to see in bad weather than lights of less intensity at shorter ranges.

For a deviation of θ° the passing distance, measured horizontally to a point vertically over the beacon is S sin θ, and the distance x from passing point to beacon is $\sqrt{(S\sin\theta)^2+h^2}$. For an aircraft at any point along the course y miles distant from the passing point, the distance x between aircraft and beacon is given by—

$$x = \sqrt{(S\sin\theta)^2+h^2+y^2} \quad \text{............(viii).}$$

From equations (iii) and (viii) the conspicuity of the beacon can be calculated for any point y miles distant from the passing point, or, since y = d—T′v, the conspicuity can be obtained at the end of any given period T′ after entering the beam. In Fig. V. curves have been plotted showing the increase in conspicuity of beacons of 1,000 and 100,000 candle power from the time they become visible till they are passed.

The deductions from these results are that an increase in power not only leads to an increase in spacing distance, but enables beacons to be seen more clearly and for a longer time.

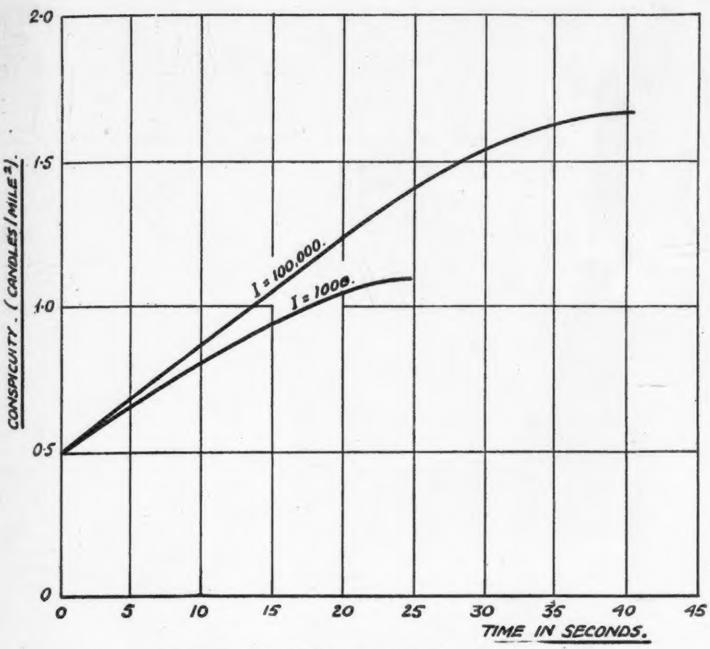
It will be understood that high intensities are required in the directions from which the light will probably be picked up in bad weather and are not necessarily required in directions such that beacons will be seen at very long range.

The trend of British practice in regard to light distribution is shown in Fig. VI., in which curve A shows the vertical distribution of one of the latest types of beacon developed in this country, while curve B is representative of the beacon used in large numbers abroad.

The main characteristics of the two beacons are tabulated below:—

	Beacon A	Beacon B
Intensity 1° above horizontal	1,300,000 candles	1,750,000 candles
,, 2° ,, ,,	590,000 ,,	590,000 ,,
,, 5° ,, ,,	190,000 ,,	negligible
,, 10° ,, ,,	85,000 ,,	,,
,, 15° ,, ,,	60,000 ,,	,,
Wattage of lamp employed	1,500 ,,	500
Flash period	0.12 second	0.1 second
Total period (signal & eclipse)	3 ,,	10 ,,

* This assumption has been made for the sake of simplicity, but the arguments which follow are equally applicable to beacons having similar but non-uniform light distributions. A graphical method which can be used to find $\sqrt{D^2-h^2}$ and S is given in Appendix B. of British Standard Spec., No. 563—1934.



(*Royal Air Force Official—Crown Copyright Reserved*)

Fig. V.

A study of these figures will show that in the British design great sacrifices have been made in the main beam intensity in order to decrease the period between flashes and to provide a substantial amount of light in the upper angles for bad weather conditions.

It has been shown by Langmuir and Westendorp* that the time taken to locate a flashing beacon is partially dependent on the period elapsing between flashes, and that this period should become shorter as the visibility becomes worse. In Europe there is a general tendency, based on experience, to use periods not exceeding five seconds.

In regard to the amount of light which should be provided for bad weather conditions it is questionable whether enough has yet been allowed even by British practice, which goes further in this respect than that of other countries.

If all the light available is concentrated into a narrow beam of one or two million candle power and directed at approximately 1° above the horizontal the consequences are as follows. In clear weather several beacons along the route can be seen simultaneously and they are of such outstanding brightness that there is no possibility of mistaking them for any other lights. It is difficult to believe that the first advantage is very necessary and the second could be gained by the employment of a much lower intensity. The disadvantages are that residents in the neighbourhood of the beacons are inconvenienced by the flashes and that in bad weather a large part of the light emitted is wasted.

This latter point will be understood by reference to Fig. VII. which shows that the light distribution of beacon A previously referred to, with the intensities corrected by equation (iv.) to allow for the flash period. When approaching the beacon at a height of 3,000 feet in bad weather (atmospheric transmission 2 per cent. per mile) the light first becomes visible when the beam is entered at a point for which the angle of elevation measured from the bacon is about 14° 30′. Of the total light flux available 93.5 per cent. (represented by the blackened, cross-hatched, and shaded areas on Fig. VII.) is emitted below this angle and is, therefore, entirely wasted. Similarly, when approaching at 2,000 feet 83 per cent. is wasted (represented by the blackened and cross-hatched areas) and at 1,000′ 64 per cent. (represented by the blackened area).

Whether it is advisable to increase further the visibility of airway beacons in bad weather conditions at the expense of clear conditions is a debateable question. It should be understood that diverting still more light from the main beam to the upper angles will not materially increase the range in these angles, but it will render the beacon very much more conspicuous in bad weather and therefore less likely to be passed unobserved. Reference to the curve for 2 per cent. transmission given in Fig. II. will make this clearer. If, for example, the beacon intensity is increased from 100,000 to 200,000 candles the range is only increased from 2.63 to 2.77 miles, but at the former distance and at lesser distances the doubled candle power will make the light twice as conspicuous as it would have otherwise been.

1½ k.w. single-flash beacons, designed to Air Ministry specification, in which the optical system departs considerably from standard practice, have recently been installed on the Croydon-Lympne airway. These beacons are interesting because they were designed to meet definite requirements in regard to light distribution and flash period, and these requirements have been met without attempting any compromise in either characteristic such as would be entailed by the adaptation of existing apparatus.

The beacon is shown diagrammatically in Fig. VIII. in which the revolving parts are shown in the sectional elevation by thick lines and the stationary parts by thin lines. The path of the light rays is indicated by broken lines. It will be seen that two beams of light are emitted and that two separate lenses are used to produce each beam; the inner lenses controlling the horizontal divergence, while the outer lenses give the required vertical distribution.

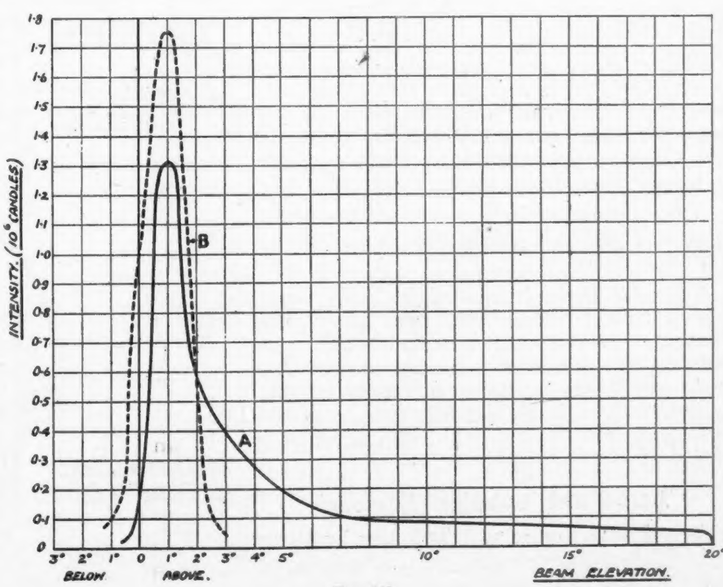


Fig. VI.

* loc. cit.

By this arrangement the resultant beam has the same horizontal divergence at all angles of elevation and consequently the duration of the flash exhibited is the same for any direction of observation. An additional advantage is that the light distribution can be accurately predetermined.

The beacon is shown in Fig. IX. with the inspection doors open. It incorporates an automatic lamp changer and a red identification light which flashes a morse character. The light valve control and contractors are seen on the left in the photograph.

A new form of beacon has recently been developed which combines a course indication with the inherent advantages of the single-flash type. The beacon exhibits its signal through 360 degrees in azimuth and over a vertical angle of 20 degrees, but it differs from the constant speed single-flash type by having its speed of rotation materially reduced at each half revolution. This slowing-up occurs when the light is projected along the route and within a predetermined angle on either side; at the same time the beacon is arranged to oscillate once within this angle before continuing its revolution.

The effect of the speed variation is to produce an apparent luminous intensity in directions near the course considerably greater than in other directions. The effect of the oscillation is to make the beacon exhibit a definite "on course" signal, the character of which changes as soon as a deviation is made to either side.

The beacon projects two beams spaced 180 degrees apart, and revolves once every ten seconds. It oscillates through an angle of 20 degrees, i.e., 10 degrees on either side of the course.

The light character in azimuth is shown in Fig. X., in which the duration of the flashes is proportional to the thickness of the curve and the dark periods between flashes are proportional to the spaces between the small circles shown on the curve.

Flying along the true course the character exhibited is a regular triple flash repeated at intervals of five seconds. If deviation takes place towards the port side the character changes to a double flash, followed by a single flash.

If the deviation is to starboard the character changes to a single flash, followed by a double flash.

Near the outer limits of the angle over which course indications are given the character changes to a double flash, and outside this angle to a single flash. Air tests have shown that a deviation of one mile from the track is noticeable from the change in the beacon light character at a range of thirty miles.

Aerodrome Location Beacons.

Aerodrome beacons are usually built up out of Neon tubes, arranged in the form of a truncated cone and placed close to the aerodrome. Neon beacons are low intensity

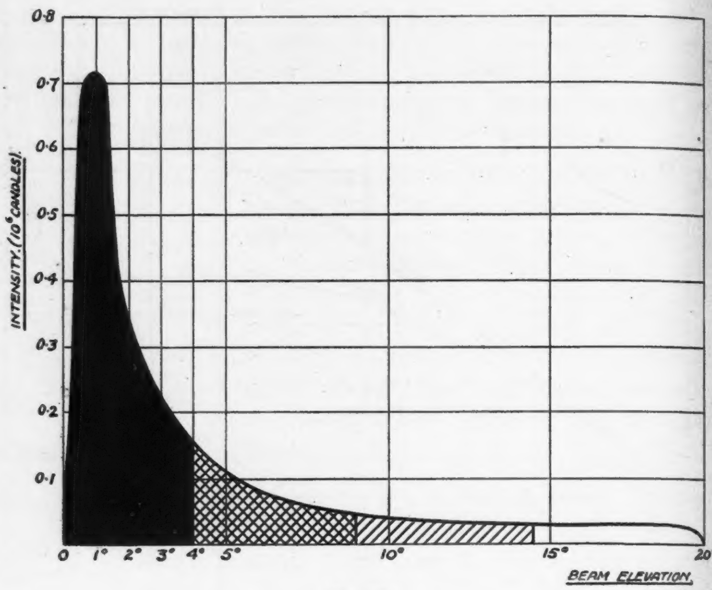


Fig. VII.

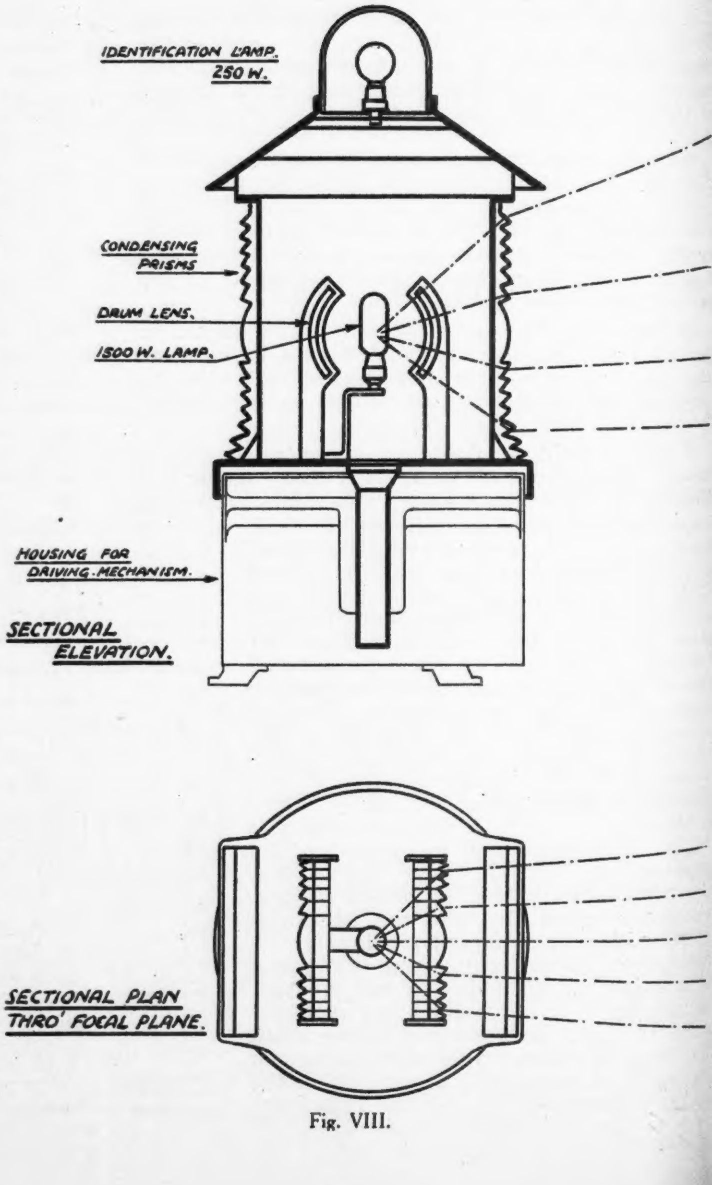


Fig. VIII.

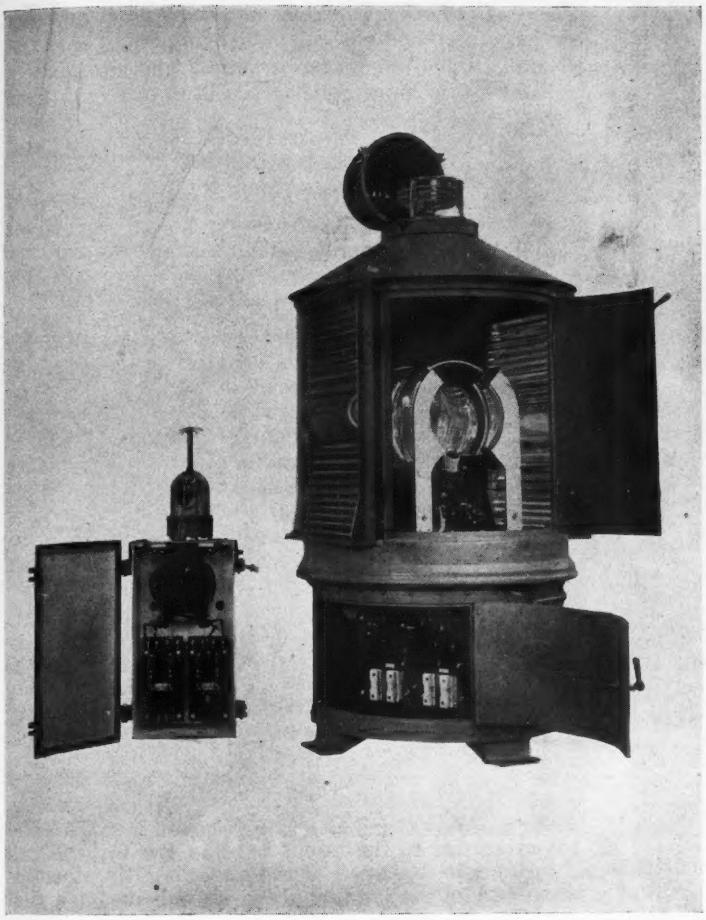


Fig. IX.

lights, giving from about 3,000 to 5,000 candles of red light, and have the advantages that they do not dazzle pilots landing, they can easily be made to flash a Morse character identifying the aerodrome, and they are distinctive in appearance.

The colour distinctiveness which Neon once possessed is rapidly disappearing with the growth of Neon advertising in towns and cities. There are now many cinemas of which the exterior Neon lighting has a total intensity exceeding that of the average Neon beacon.

Neon light has no special fog penetrating qualities. It is scattered and absorbed by the atmosphere in just the same way as any other red light and, when visibility is down to a mile or less, a Neon light cannot be seen appreciably further than a white light of equal intensity.

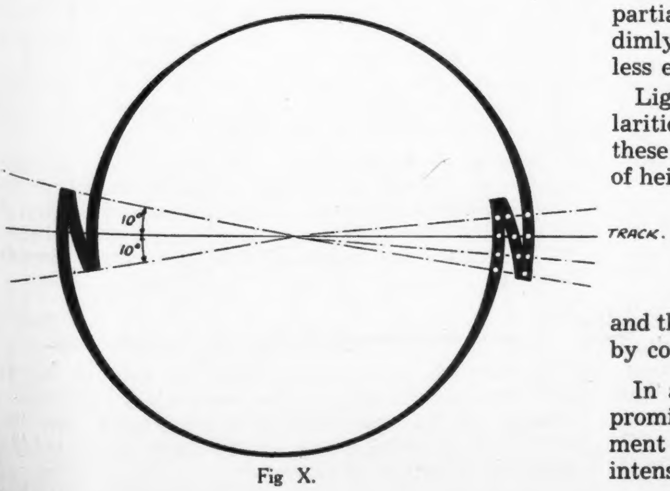


Fig X.

Blind flying may necessitate the use of a more powerful aerodrome beacon than the Neon type in the future. A pilot coming out of the clouds, somewhere in the vicinity of the aerodrome and with ground visibility poor, has no idea of the direction in which to look for the beacon, which must be picked out from other red signs by its flash period. It is therefore possible that a light which is recognisable by virtue of both intensity and character, may in time become preferable to one which is recognisable by character alone.

Aerodrome Floodlights.

The floodlighting of aerodromes for night landings can be accomplished in a number of different ways. The best and most convenient system, which is, incidentally, the most expensive, is to instal a number of fixed floodlights at intervals round the aerodrome boundary. One or more floodlights can be turned on, according to the direction of the wind, and as the whole installation can be remotely controlled, there need be no delay in bringing the lighting into action or following changes in wind direction.

Tests have recently been carried out in Germany, described in a report issued by the Luft Hansa in August, 1933, to establish the requirements for adequate floodlighting. The conclusions reached are as follows:—

(a) The lighted area should measure 600 by 300 meters.

(b) The minimum illumination over this area should be 0.25 foot-candle (3 Hefner lux) and the maximum illumination should at no point exceed 2.1 foot-candles (25 Hefner lux).

(c) Lighting from one point is preferred.

Conclusion (a) does not state a minimum requirement but defines an area sufficiently large for a fast machine to be landed without difficulty and with nearly the same margin of safety as in daytime.

Conclusion (b) aims at reasonable uniformity of illumination. A very high foreground illumination partially destroys dark adaptation and the more dimly lighted parts of the landing surface become less easily discernible.

Lighting from one point emphasises surface irregularities by the sharpness of the shadows, and it is on these shadows that a pilot relies for the estimation of height when near the ground.

The design of a dioptric floodlight, to comply with the requirements of the Luft Hansa, has been studied by the Netherlands Lighthouse research laboratory, and the following account of the experiments is given by courtesy of Mr. Van Vloten.

In attacking the problem the only method which promised to be successful was to find a shape of filament which would increase the maximum luminous intensity and reduce the foreground illumination.

Theoretically the height of the filament coils above the focal plane can be limited in such a way as to provide uniform illumination at all distances. A filament adapted as far as possible to this form is shown in Fig. XI. The outer coils are 2 cm. long, those following are 1.4 cm., and the eight middle coils 1 cm. The spherical lamp bulb is silvered on the side remote from the lens, and the luminous intensity

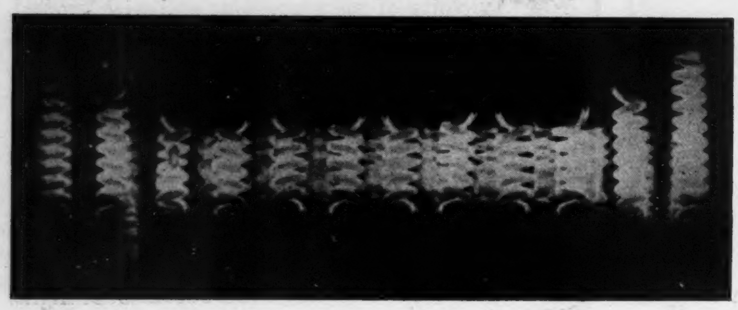


Fig. XI.

perpendicular to the plane of the filament is approximately 28,000 candles.

6.6 k.w. lamps of this type, used in drum lenses of 40 cms. focal length, gave intensities of about 600,000 candles, and were generally satisfactory. The investigations were, however, continued as the vertical divergence of the beam was greater than necessary, and it appeared possible that the brightness of the filament could be further increased.

In the lamp just described the space between the coils is practically filled by coil images, of which the brightness is considerably less than that of the coils themselves. If the entire radiating surface entering into consideration for the illumination of the more

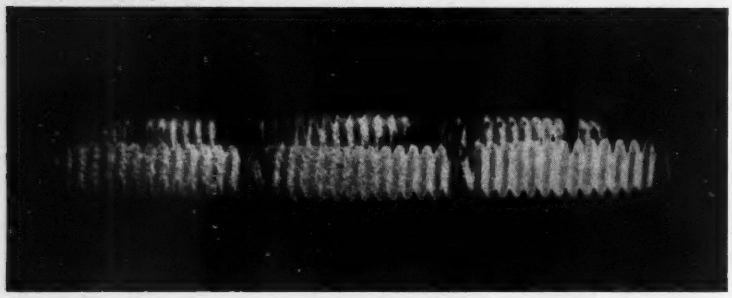


Fig. XII.

distant parts of the landing area could be occupied by a single filament coil, then the intensity in these directions would be increased.

This consideration led to the use of a lamp in which the filament consisted of a thick horizontal coil. (Refer Fig. XII.) To provide the necessary foreground illumination a reflected image is projected by the silvered bulb about half-way above the coil and fills up spaces between the turns along the upper edge.

In this filament the wire is wound to a helix having an external diameter of 8 mms. and a length of 8.5 cm. The consumption of the lamp is 5.6 k.w., and the candle-power developed in a 3rd Order lens is 1,200,000.

This lamp marks a definite advance in floodlighting practice. Not only does the filament shape produce relatively even illumination over the landing area, but the light emitted is very efficiently used. The latter advantage is of special importance in connection with fixed floodlight systems, in which the cost of the supply cable running round the aerodrome is a heavy item in the total cost of the installation. Any increase in optical efficiency, bringing about a corresponding reduction in power input and cable costs, will tend to a more general adoption of fixed floodlights.

Boundary Lights.

Aerodrome boundary lights, which are designed to indicate the limits of the landing area, are not yet internationally standardised in character and may be red, orange, yellow, or white, and either fixed or flashing.

The employment of fixed orange lights is recommended in this country, the colour limits being chosen so that there is a risk of confusion with white rather than red light. It is obviously more dangerous to mistake an obstruction light for a boundary light than to mistake the latter for a white light. It is too early to say whether orange light alone will prove sufficiently distinctive or whether a flashing character is also essential.

A boundary light which has recently been introduced is fitted with an internally illuminated opal glass cylinder three feet high below the amber light. This makes the light more easily recognisable and indicates height and perspective to a pilot when approaching to land. (Refer Fig. XIII.)

Neon tubes are employed as boundary lights at a number of German aerodromes. Up till recently straight tubes have been used, when it was found advantageous to use tubes bent in the form of an obtuse angle, the apex of the angle pointing towards the centre of the landing area. By this means a pilot can see, when flying over the boundary lights, whether he is entering or leaving the aerodrome. This additional indication given by the lights has been found very useful in bad weather when the further side of the aerodrome can not be seen.

An experimental installation of twelve sodium tube boundary lights has been made in Holland. The luminous emission of a sodium lamp is about ten times that of an incandescent lamp with a coloured filter. It is stated as a result of night flights during the summer of 1934 that sodium light has a specific character and that the system is satisfactory.

Since boundary lights are used to indicate the limits of the landing area their light distribution can be calculated on the assumption that all the lights should be equally visible while circling the aerodrome preparatory to landing. In the case of an aerodrome 1,000 yards in diameter, if the circuit is made a quarter of a mile outside the boundary at a height of 1,000 feet, the light distribution to give all the lights the same conspicuity, when t = 2 per cent. per mile, is shown in Fig. XIV.

This curve is based on a conspicuity of one mile candle so that the lights will be clearly visible under the conditions described. An arbitrary intensity of $2\frac{1}{2}$ candles is allowed down to 5° below the horizontal to ensure the lights will be seen from aircraft taxying.

Aerodrome Obstruction Lights.

Aerodrome obstruction lights are red in colour and fixed in character. The theoretical light distribution can be calculated if it is assumed that the period of warning given by the light shall be the same at all angles of approach.

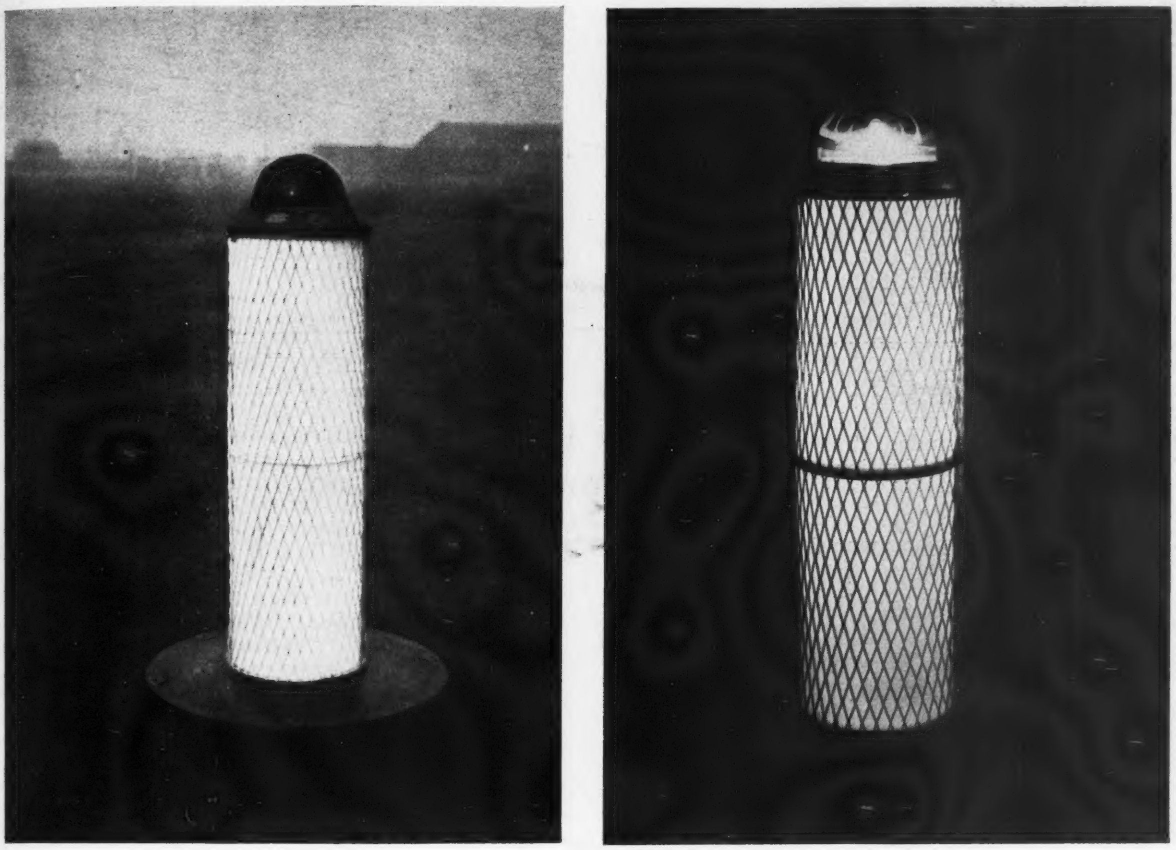


Fig. XIII.

The following symbols are used:—

p = period of warning for avoidance of collision with obstruction.
v = air speed. V = wind velocity.
θ = angle of elevation of beam from obstruction light, measured from the horizontal.
θ' = gliding angle of aircraft.
d_θ = range at which obstruction light becomes visible when the aircraft is at an angle θ to the obstruction.
h = height at which obstruction light is visible.
x = height by which obstruction is to be cleared.

As landings should always be made into wind, it follows that an obstruction will not normally be approached at angles less than θ', unless the aircraft is flown with engine on at a dangerously low altitude or landed with the wind.

It is impracticable to design a light to guard against abnormal circumstances, and it is considered that sufficient warning will be given if the intensity provided to satisfy the range for θ', is continued down to the horizontal.

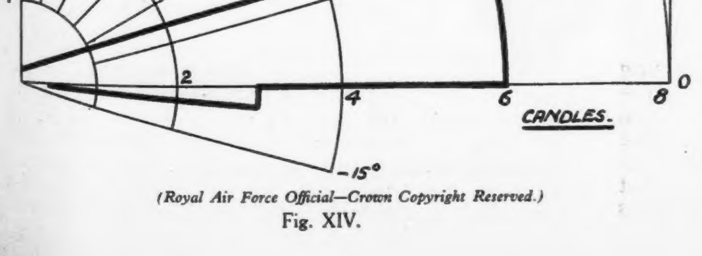


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Fig. XIV.

The height lost in a given time depends on v and θ' and is independent of V. Referring to Fig. XV., when V = O, h = vp sin θ' + x. Since h is constant for all values of V:—

$$d_\theta = \frac{vp \sin\theta' + x}{\sin\theta} \qquad \text{(ix)}$$

Below the horizontal there seems to be no justification for providing high intensities. Before taking off, a pilot has ample time to make sure of the location of all obstructions likely to be dangerous. An intensity of $1\frac{1}{2}$ candles, giving a range of approximately 1,000 yards when atmospheric transmission is 2 per cent. per mile, appears sufficient.

The vertical distribution curve for an aerodrome obstruction light is shown in Fig. XVI. and has been calculated on the following assumptions.

p = 30 seconds when atmospheric transmission is 2 per cent. per mile.

v = 80 m.p.h. (gliding speed).

θ' = 10°.

x = 100'.

Having obtained values of d_θ for various values of θ, the intensities required to make the light visible at these ranges can be found from equation (iii).

Fig. XVII. shows a dioptric obstruction light constructed to Air Ministry requirements, which, when equipped with a 25-watt vacuum type lamp, satisfies the requirements outlined above.

The outer globe is made of red selenium glass having a transmission of about 25 per cent., and the inner refractor is clear pressed glass, very lightly acid etched to give the required divergence.

Airway Obstruction Lights.

The light distribution of airway obstruction lights differs from that of aerodrome obstruction lights because the direction of the wind relative to the line of flight is variable. A collision can occur either when the aircraft is flown horizontally on a level with the obstruction or when altitude is being lost in a glide.

In the first case the range of the obstruction light must obviously be based on the speed of approach with a following wind and is given by—

$$d_\theta = p\ (v+V) \quad \text{........................(x)}$$

In the second case equation (ix) is applicable, with the difference that for a following wind θ may be less than θ′ and the curve must be extended. The limiting angle to which the distribution given by (ix) should be carried is found as follows:—

The horizontal displacement d′ of the aircraft during the period p is given by—

$$d' = p\ (v \cos\ \theta' + V) \quad \text{...............(xi)}$$

therefore

$$\theta_{min} = \tan^{-1} \frac{vp \sin\theta' + x}{d'} \quad \text{..............(xii)}$$

In bad weather neither the time nor place of appearance of an airway obstruction light is known exactly. The period of warning given by the light should therefore be at least as long as that given by an aerodrome obstruction light; preferably it should be longer.

Assuming—

p=30 seconds when atmospheric transmission is two per cent. per mile.

v=150 m.p.h. maximum cruising speed. 80 m.p.h. speed in glide.

V=30 m.p.h.

x=100 feet.

Then, according to equation (x), the horizontal intensity of an airway obstruction light should be approximately 400-candles. From equations (xi) and xii) the intensity of 8½ degrees above the horizontal should be 15 candles, while from 12 degrees to the zenith the distribution will be as shown in Fig XVI.

The author's acknowledgments are due to the Director of Technical Development for permission to publish the paper, to Dr. F. Born, Messrs. Chance Brothers and the Gas Accumulator Company for the use of data and photographs, and to Mr. E. S. Calvert for his very helpful criticism of the paper.

DISCUSSION.

Major R. Mealing expressed the hope that the paper would find a permanent place in the records on this subject at the Science Museum, because he and others on the Lighting Committee had for a long time believed there was a need in this country for a permanent reference library on this subject. Although it had not yet been possible to come to an arrangement with Dr. Bradford, the librarian at the Science Museum, it was a proposal that had been considered favourably, and it was to be hoped that this paper would find a place in that library for permanent refer-

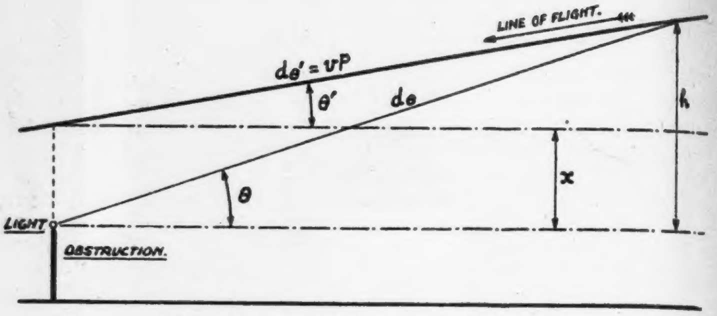

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Fig. XV.

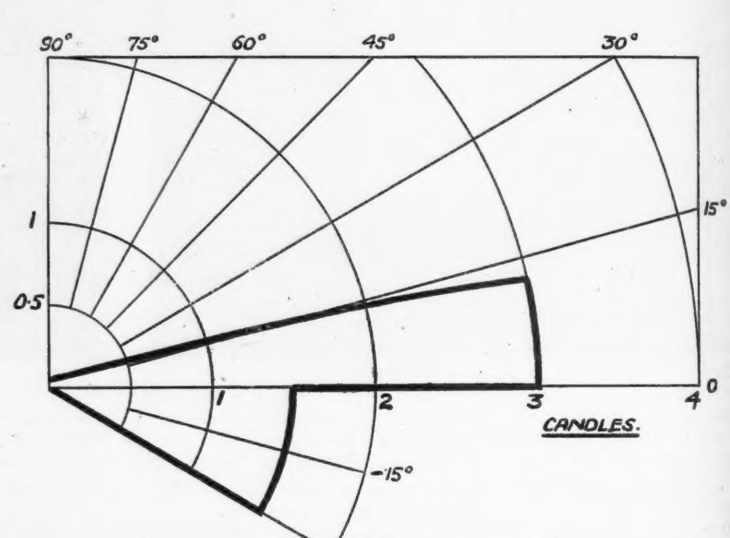

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Fig. XVI.

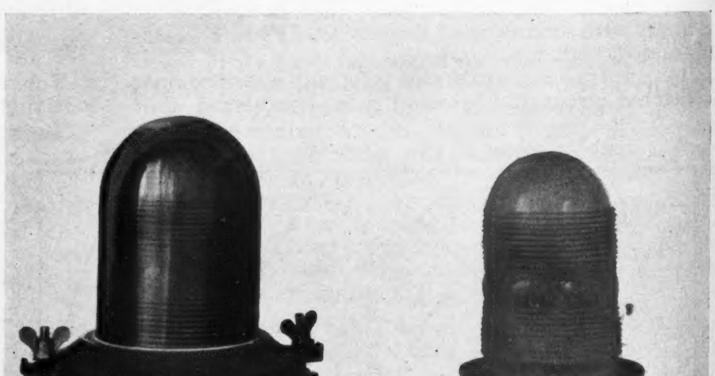

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Fig. XVII.

ence. The paper had been written, he believed, as the result of a paper which he himself read some eighteen months ago on the policy aspect of this subject, and it was then suggested by Col. Sylvester Evans that a technical paper should follow as soon as the British standard specification covering aviation lighting was issued. The specification had been issued, with the result that Mr. Green had prepared this technical paper.

In discussing the paper, continued Major Mealing, he proposed to comment upon the policy aspect. If he were asked who was going to provide this lighting, he said at once, quite frankly, that he did not know; but if he dared have any opinion at all—and it was purely a personal one—it seemed to him that we must look to the Air Ministry in this connection, because, so far as he could see, nobody else could possibly do it, so far as airway lighting was concerned, at all events. As regards aerodrome lighting, it might be said that those who provide the aerodrome should provide the lighting; but the question immediately arose whether this could be done without assistance; but whether such assistance would be forthcoming for this lighting, which was so very necessary now that night flying was increasing to such an extent, including the carrying of mails, he would not like to say. Nevertheless, he felt it should be considered, because he saw no other means by which progress could be made with night flying. Although he had hinted at possible Government assistance, there should, of course, also be money obtained by way of payment for the use of aerodromes, and there was no reason why there should not be some form of dues in respect of lighting. After all, the mercantile marine paid dues to Trinity House, and there was no reason why something of the same kind should not be done both for airway lighting and aerodrome lighting. That, however, was a big subject, although the sooner it was considered the better. There had been references in the papers recently to what was known as the National Airway Board, and that might be a step towards a solution of this problem, because it was easier for an outside body than a Government Department to deal with these things quickly.

Mr. Percy Good said that the author had been an active member of the B.S.I Committee—of which Major Mealing was Chairman. This Committee had been instrumental in publishing, first, a Guide to Aerodrome Lighting, and then the British Standard Specification for Aerodrome Lighting, which was issued last year. Those who had been closely associated with the work of this Committee had been very much impressed with the scientific work which Mr. Green had been doing, and the Air Ministry had contributed their full share to the technical advance of this problem. The co-operation of the Air Ministry with the makers of apparatus and those engaged in flying had been very valuable. This Committee had also been continuously in contact with the international position and had been participating in international meetings held during the past few years, and was preparing for one to be held this year in Berlin, with the result that the experience of the technicians and administrators in the different countries had been brought together in a most useful manner. He welcomed this paper because it indicated the value of the work that was being done in this country in this conection, and he assured Mr. Green that his individual efforts were very much appreciated both at home and abroad.

Mr. Gordon England said this was a subject of tremendous interest to the members of the Royal Aeronautical Society, and as a member he was very grateful for being allowed to take part in this discussion. Speaking from the pilot's point of view, Mr. Gordon England referred to the author's reference to the single-flash beacon as perhaps the most important form of light used in aviation, but quite frankly he felt that this was open to question. Speaking broadly, he would have been inclined to say that the use of beacons for airway lighting would quickly be out of date, as they might be superseded perhaps by wireless control in one form or another. When he was recently in America, where there was a highly developed system of beacons, he had been anxious to find out from pilots there whether they considered visible-light beacons more important than wireless directional control, and there was then a very definite tendency on the part of a great many of them to prefer radio beacons. He was not quite sure whether there had been a change in that outlook since he had returned, but certainly at that time they were far more concerned with adequate lighting of the aerodromes than light beacons en route, and they used very largely the shadow-beam floodlight for aerodrome use. Speaking purely from the pilot's point of view, although the flying he did during that visit was as a passenger, his own preference was for the shadow beam. The night-flying that he did over there was very useful in that he had encountered some very bad weather conditions. One landing was made in the dark in a blinding snowstorm, and he did not believe that they would have had a very happy landing under those conditions with anything but shadow-beam floodlight. Again, speaking as a passenger, the landing on this occasion appeared to be relatively child's play, and in contrast he could imagine that floodlights facing the pilot in all directions might have been very teasing in a snowstorm. In Europe these conditions were likely to be met, and he was wondering whether we ought not to exploit the shadow beam a good deal further for aerodrome lighting.

Another point was that if we were going to use any form of intermittent light, for goodness' sake let there be some standardisation in periodicity secured at the beginning, because it would be extraordinarily awkward if there came into existence a mass of different timid intermittent light beacons all intended to mean the same thing such as were now used in the traffic lights on the roads which are a confusion to road users, because their frequencies all varied in the change from orange to green lights; altogether the whole position of the roads was becoming most disconcerting because of these different time lapses. Therefore, in the matter of flashing lights for aerial navigation, a serious effort should be made to arrive at standardisation so, for example, immediately a pilot saw a certain light and flash he knew that it indicated the boundary of an aerodrome. Such standardisation was of immense importance as an aid to aerial navigation.

Mr. Oliver Simmonds, M.P., remarking, that generally speaking British engineering had always prided itself on a logical development, whether it be in marine, civil, or mechanical engineering—and he thought we had also been fairly logical in the development of our aircraft structures and engines—said that in the matter of ground organisation in connection with flying, he rather feared that this country had fallen far below our natural level. Therefore, the paper by Major Mealing, which had been referred to and also the present paper, were important as indicating that although we had been thinking for some fifteen years of civil air routes, and of installing lights throughout the British Isles and the British Empire, we had not yet commenced to face the fringe of the problem. It was astonishing even to think that Major Mealing should that evening, after sixteen years of civil aviation, ask who was going to pay for the lighting. Although not accusing Major Mealing personally, he felt that to take up such a position to-day, when it was time that the lighting had actually been accomplished, was deplorable, but it was typical of the unfortunate way in which we were settling down to take rather a third-rate position in international aviation. Personally, he felt that we had approached this

problem in this country wrongly. The Government had endeavoured to pass its responsibility on to the municipalities. An effort had been made to encourage municipalities to open air-ports, both for their prestige and for their profit. That, however, was really a fantastic idea, because an air-port gave no more profit than a railway station. It was the trains and the aircraft and the ships which gave the profit. From that point of view he was delighted to hear that Major Mealing had no personal predilection in this matter, because we should not commit the folly again of telling municipalities that if they put up beacons for a distance of thirty or fifty miles from their particular towns, it would be a very fine paying proposition, when in point of fact it would be nothing of the sort. On the contrary, it would cost money for installation and maintenance. The only way to approach the whole problem of aerodrome and airway lighting and radio direction, was for the Government to make a bold decision and to equip these Islands and the Empire in a modern manner in this respect. As a result of this paper he felt that nobody in the future who had charge of policy could say that that matter could have been pushed forward "if only the technical people had made up their minds." That was the sort of smoke screen behind which those who had to define policy usually sheltered themselves, but the paper had made it perfectly clear that the technical people had made up their minds, and therefore he hoped that there would be no more beating about the bush, and that some definite policy would be decided upon.

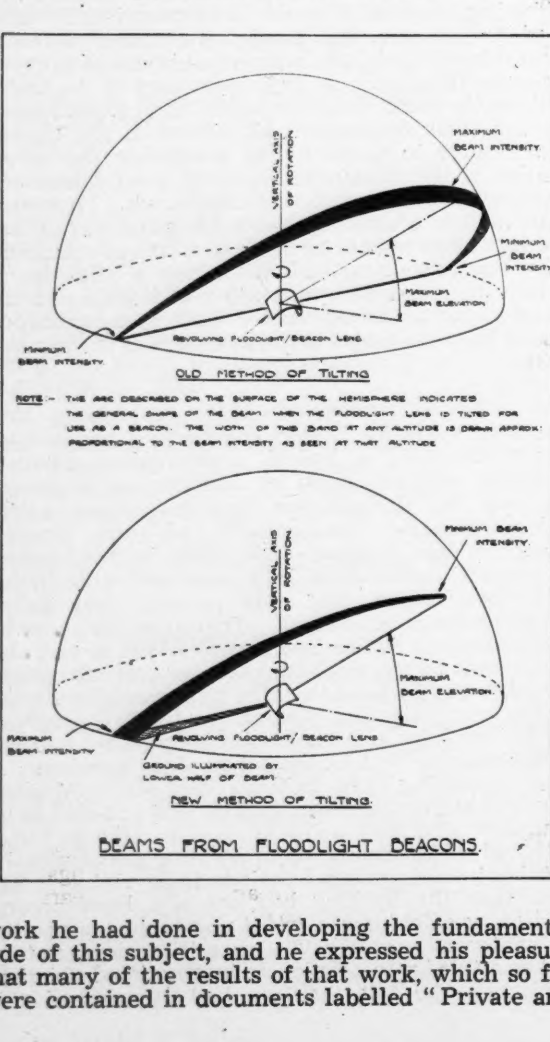
Dr. Hampton said those who had been privileged to be associated with Mr. Green on various technical committees appreciated the enormous amount of work he had done in developing the fundamental side of this subject, and he expressed his pleasure that many of the results of that work, which so far were contained in documents labelled "Private and Confidential," would now be available for general use, and also that the authorship of them could be acknowledged.

One direction in which the author's work had been of great use in the actual development of lighting apparatus was the manner in which the fundamental questions relating to the distribution of light in airway beacons had been investigated. Hitherto nobody had had a clear idea of what was needed, the general idea being to put as much light as possible along the axis and hope for the best. A sort of approximation was made which was regarded as good enough, and a typical instance was the floodlight beacon similar to the one at Croydon, which was made something like a beacon by tilting it up into the air, which operation, however, gave a high intensity at 10 or 20 degrees in the air, and from the nature of the tilting the lower intensities were given along the horizontal, which was just where the maximum was required. Moreover, from the nature of the tilting the character of the light varied at different angles of elevation, with the result that there were double flashes on the horizontal and a single long flash at the maximum elevation.

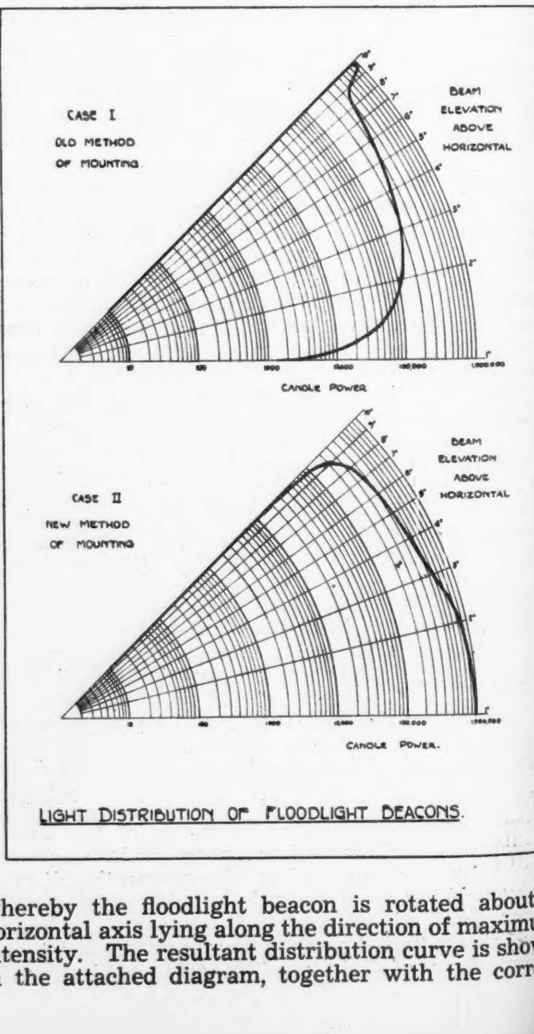
In this connection Dr. Hampton said that a different method of treating this problem had recently been developed by which the floodlight was tilted about an axis at right-angles to the one previously used, and the distribution of light was a very close approximation indeed to the ideal curve, and the apparatus gave a single flash at all angles of elevation.

In connection with the remarks recorded above it may be desirable to give a slight amplification of the new type of tilting floodlight beacon.

The new system consists in an arrangement whereby the floodlight beacon is rotated about a horizontal axis lying along the direction of maximum intensity. The resultant distribution curve is shown in the attached diagram, together with the corres-



BEAMS FROM FLOODLIGHT BEACONS.



LIGHT DISTRIBUTION OF FLOODLIGHT BEACONS.

ponding curve for the earlier method of tilting. The second diagram shows graphically the details of the two systems.

It should be mentioned that the new method forms the subject of a British Patent Specification.

Mr. W. A. VILLIERS, speaking as one who has charge of the design of aerodrome lighting equipment, first referred to the aerodrome location beacon in connection with which the author had said that the value of the characteristic colour of Neon as an element in visibility was fast disappearing, due to the fact that there were so many similiar signs on cinemas, etc., so that they were likely to be confused with the aerodrome beacon. That being so he asked whether the author could suggest any other colours which would not be thus confused. Then it had been suggested in the paper that the time might be near when the candle power from the location beacon might have to be increased. If that were so, what would happen in clear weather when the wretched pilot was circling an aerodrome prior to landing and was being dazzled by these higher candle-power lamps and probably, as a result, would make a bad landing. Was there any method by which the pilot could see the beacons at some distance and yet, when endeavouring to land, would not be dazzled?

Speaking with regard to aerodrome floodlights, Mr. Villiers said he did not agree with the author that fixed floodlights round the aerodrome, although the best, were the most expensive. He agreed that they were the best, but disagreed that they were, nowadays, the most expensive when all factors were taken into consideration. The other systems available were the mobile type of floodlight, or the shadow-bar type, both of which involved considerable maintenance costs as compared with fixed floodlights, and he claimed that the system of fixed floodlighting was less expensive, as well as being the best in the long run. He disagreed with Mr. Gordon England as to the advantages of the shadow-bar system of aerodrome floodlighting, and pointed out that with a proper system of fixed floodlights there were not a lot of floodlights shining in all directions. His own view was that in a proper system, the floodlights should be spaced round the aerodrome boundary, and that landing should take place from behind the floodlighting. The disadvantage of the shadow-bar floodlight was that it depended on the actions of two people, one on the ground and one in the air, who could not communicate with each other, and if either of them made a mistake there was liable to be a bad landing.

As regards the account given by the author of the experiments carried out in Holland with aerodrome floodlights, this was not such an advance in floodlighting practice as the author seemed to assume, because the line filament was developed first and had been used in England long before the Dutch tried it. In England, however, a trough reflector was used instead of the dioptric lens, and he claimed that the trough reflector was the right thing to use with a line filament. If a dioptric lens was used there must be either low efficiency or too high a vertical divergence with consequent dazzle to the pilot. Moreover, the trough reflector and the line filament was cheaper and also more efficient, because this method included a greater angle of light flux. There was much more vertical control over the light distribution, and it was also possible to use more than one lamp, which was very important in maintaining the continuity of the lighting system, and avoiding the possibility of accidents in landing. It was very difficult to put two or more lamps into apparatus using dioptric refractors.

Lieut.-Commander DAMANT said he was not very clear with regard to the Dutch unit employing the dioptric lens and a line source of illumination. Was the line source vertical or horizontal and had the dioptric lens a point focus or a line focus?

Mr. J. S. DOW said there was one remark in the paper which seemed to imply that the author did not accept the prevalent view that red light penetrates the atmosphere better than the other end of the spectrum. Was it to be taken as a fact that there was no advantage whatever in a monochromatic red light as compared with, say, an impure " mixed " red light where visibility at a distance was concerned? Apart from this question of penetration of the atmosphere, however, there was the further question of the conditions determining the perception of the light when it was only just visible. According to the author's conception of route-lighting based not on occasional very intense lights, but moderate lights placed at reasonable intervals, the conditions determining when a beacon just disappeared from sight were evidently important. Did the author consider that the main consideration was simply the candle power in the direction in which the light was viewed; or was it possible that a source containing vivid green lines in its spectrum, such as some of the newer electric discharge lamps, might be better. It was known that in the dark the central region of the eye was insensitive so that a faint light invisible to direct vision could still be seen out of " the tail of the eye," i.e., by oblique vision. In these circumstances the peripheral part of the retina was practically blind to the red end of the spectrum, and, therefore, he imagined that light from the green end of the spectrum might definitely be better. That might possibly give the new lights an advantage in that respect. Finally, Mr. Dow said he noticed that the author in dealing with aerodrome lighting dealt with fixed lights only. He would like to know whether fixed illumination of the landing area must be regarded as essential, and how far landing by the aid of suitable portable projectors mounted on the alighting aeroplane was a feasible operation.

Mr. H. W. SIMS-WHITE (Communicated). I was particularly interested in the question of floodlights and must say that I agree (even after subsequent consideration) with the remarks made by Mr. Gordon England, that is, that the shadow-bar is, so far the best solution of the problem. In view of the opinion expressed by Mr. Green, however, I should be very grateful if he, or any other member of your Society who is familiar therewith, could furnish me with some information in regard to the all-round utility of the shadow-bar floodlight at Heston.

Mr. H. N. GREEN, replying to the discussion, said he could concede Mr. Gordon England's point as to airway beacons not being the most important lights used in aviation; what he should have said was that they were the most expensive. The American lack of confidence in beacons was possibly due to the fact that in U.S.A. nearly all beacons are of the searchlight type, giving practically no light above 3°, with the result that they were difficult to locate in conditions of poor visibility.

The shadow bar floodlight, referred to by Mr. Gordon England, had been used in this country, but was regarded as an economical method of lighting, giving reasonably satisfactory results, which could be employed when insufficient money was available for either a mobile floodlight or system of fixed floodlights.

There was no inconvenience from glare when using either of the two latter systems. Landings were always made over the light and down the beam. The vertical divergence was so small that it was only after flattening out, a few feet from the ground, that the pilot came into the beam. The standardisation of the colour and flashing character of boundary lights was

not quite so easy as might be imagined. Several efforts had been made to get something standardised internationally but, although it might seem a very simple matter on which to reach an agreement, so far little progress had been made.

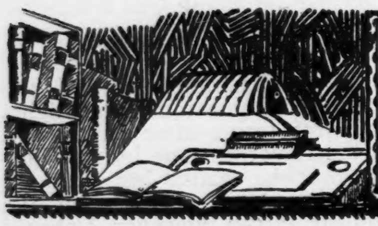
As to an alternative colour for aerodrome beacons, mentioned by Mr. Villiers, some experiments were being carried out on the possibilities of green and blue light. It had been suggested that green was a better colour than red because the former signified safety and the latter danger, and that green was therefore the most appropriate colour for marking landing grounds. Mr. Dow had also raised the point that some of the new gas discharge lamps, which had green lines in the spectrum, would be seen more easily by oblique vision because a green light can be seen very much more easily parafocally than when looking directly at it. Unfortunately, these new light sources were of such relatively low brightness that they were not suitable for use with lenses, and therefore when requiring intensities of the order of 1,000,000 candle power it was necessary to rely on the incandescent lamp. The question of avoiding glare when pilots were landing had also been mentioned by Mr. Villiers, and that might be accomplished by putting beacons a short distance away from the aerodrome. At Le Bourget, however, a searchlight type of beacon was used which Imperial Airways' pilots reported on favourably, and there was no difficulty in landing, although the beacon was on the aerodrome. As to the cost of the fixed floodlight system, the capital cost was greater, but so far there was no installation of this type in this country, so that it was impossible to say whether depreciation and maintenance would be higher. The dioptric lens used in the Dutch floodlight was an ordinary fixed lighthouse lens, and the filament was mounted horizontally at the focal point. According to the Dutch claim, which personally he saw no reason to doubt, they obtained 1,200,000 candle power from a 5.6 kw. lamp, and that was more than anybody had ever claimed for the mirror system.

Continuing, the author said that Mr. Dow had somewhat misunderstood the reference in the paper to Neon light. What he had intended to convey was that Neon light was scattered and absorbed by the atmosphere in just the same way as any other red light, and he did not deny that red light was transmitted by the atmosphere slightly better than white or blue.

Finally, the author said he had not dealt with the landing lights mounted on aircraft as he considered that subject rather outside the scope of the paper.

Added: In reply to Mr. Sims White, I have made numerous landings, as an observer, by means of fixed and mobile floodlights, but only a few by the shadow bar. When landing by floodlights it is not customary to use ground flares in addition. A pilot's idea of height and perspective therefore entirely depends on the ground detail revealed by the floodlighting. With either fixed or mobile floodlights landings are always made down the beam, and in this direction shadow contrasts are sharp and detail is pronounced. In the case of the shadow bar floodlight landings are frequently made towards the light, and not only does the general illumination appear lower, but less ground detail is visible, and the landing is made on a part of the aerodrome a considerable distance away from the floodlight.

I am not prepared to say that the shadow bar might not have advantages in a blinding snowstorm such as Mr. Gordon England referred to, but under such exceptional conditions I think it would be equally safe to land over a fixed floodlight supplemented by ground flares.



REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

A Symposium on Illumination.

Edited by C. J. W. Grievson. (Chapman and Hall, Ltd., London, 1935; pp. 229, xiv.)

In a foreword Lt.-Col. Kenelm Edgcumbe explains how this volume came into being It presents, in printed form, the series of lectures organised by the National Illumination Committee of Great Britain in conjunction with the Illuminating Engineering Society in 1933. There are thus ten chapters, each by a specialist in the aspects of lighting treated. Mr. L. C. Paterson is responsible for the initial chapter reviewing "Lighting in the Service of Mankind." Dr. J. W. T. Walsh deals with two sections, "Radiation and Daylight." Mr. W. J. Jones and Mr. F. C. Smith, respectively, undertake gas and electric lighting; and Professor J. T. MacGregor Morris and Mr. G. H. Wilson with Photometry and "Redistribution of Light." The first seven chapters thus deal with general topics and principles. The last three ("Lighting for Decoration," "Public Lighting," and "Lighting for Safety, Health, and Welfare") cover applications. It is, we believe, the first time that such a series of lectures on illumination has been reprinted in volume form in this country, though the experiment has several times been made in the United States. On such occasions there is sometimes a tendency for authors to "over-embellish" their lectures afterwards, so that they become overloaded with detail. It is all to the good that in this case they have kept fairly close to the lines of their original addresses, and have not essayed more than a general survey of their subjects. Naturally there are some differences in method and outlook, but this is not necessarily a drawback in a book of this kind. One evident advantage such a series of surveys possesses is that it is easily modified in accordance with advances in technique. No doubt provision will be made for frequent revision. For the rest, the authors have acquitted themselves well, and the type, printing, and illustrations are excellent. It is the only book of its kind in this country and should be in ready demand.

Common Features of the Fire Hazard.

J. J. Williamson. (Sir Isaac Pitman and Sons, Ltd., 1935, London; pp. 190.)

For many generations the risks of fire have been closely studied by insurance companies, and the cumulative experience on this danger is very considerable. Yet there is often surprising ignorance on well-established facts, so that, as the author infers in the preface, a textbook on the subject is timely. The treatment is spread over twenty-one chapters, and there is an index and bibliography. The author covers a wide field, such matters as power, fuels, spontaneous combustion, inflammable liquids and gases, dust explosions, etc., being treated in separate chapters. Of special interest to readers of this journal, doubtless, will be chapters xvi. to xix., which deal with artificial lighting, heating, and ventilation. The treatment is lucid and concise, and the book should appeal to managers of premises anxious to be informed of possible sources of danger by fire, the obligations involved, and the precautions that may reasonably be taken.

The Problem of Street Lighting

Discussion opened by Mr. C. A. Masterman at a meeting of the North-West Section of the Illuminating Engineering Society in Manchester on April 10.

At a meeting of the North-West Section of the Illuminating Engineering Society held in Manchester on April 10, a discussion on "The Problem of Street Lighting" was opened by Mr. C. A. Masterman, who pointed out that the problem consisted in part in stating precisely the object of street lighting. Its original function as a protection against lawlessness was still one of the utmost importance and in danger of being overlooked. A failure in street lighting might cause relatively little embarrassment to the motor driver, but would undoubtedly be troublesome to the pedestrian, to whom it was always a great service in enabling him to find his way about and to avoid collisions on the footpath.

A certain exhilarating effect of bright lights made high illumination of thoroughfares a matter of civic pride. Investigations in America led to the inference that inadequate street lighting was directly related to accidents: for instance when, in Detroit, lighting was reduced by 35 per cent. owing to financial stringency the ratio of night and day fatal accidents increased from 1 : 1 to 2 : 1. An analysis by the author of statistics collected by the M.O.T. in this country led to the conclusion that in built-up areas there was 35 per cent. more probability of accidents in the dark, winter months before dusk or after dawn, than in the summer months. It appeared that providing some form of street lighting decreased the probability of accident by about one half, but there was clearly still some way to go on this direction.

In regard to the standard specification, Mr. Masterman remarked that finality had not been reached. Properly used it served as a useful guide, but it was liable to abuse when designers focused excessive light on the theoretical test points, at the expense of lighting elsewhere. In a proposed revision a multiplicity of test points had been suggested to prevent this abuse. No final conclusion had been reached in regard to the merits of side and central lighting—the former preferred by pedestrians, the latter advantageous to traffic in indicating the direction of the road ahead. There was a tendency to more powerful lamps mounted higher and spaced wider apart. On winding roads this tendency had drawbacks, and there was much to commend in the use of smaller lamps, closer together in such circumstances.

The first requirement in adequate lighting is the provision of sufficient total luminous flux. Yet "total flux per unit length of road" is alone unsatisfactory, since no distinction between useful and relatively useless light is drawn. On the Continent a system of lighting with sharp cut-off has found favour, and where the road-surface is rough a satisfactory degree of road-brightness may be achieved. With a smooth surface low brightness will result. Visibility of objects in the road depends mainly on contrast in brightness between objects and background—a consideration that has led to great stress being placed on the brightness of the roadway itself, on the assumption that objects are seen mainly dark on a light background—a condition that is apt to be reversed by the effect of a motor headlight. Systems aiming at uniform road-brightness depend on the direction of a proportion of light at angles near to the horizontal in the direction of traffic. On roads containing bends and gradients, however, the condition is less easy to secure, and the reflection from the road surface, and hence also the distribution of brightness, is much affected by a shower of rain. Indeed road-brightness in general depends greatly on the nature of the road surface and the proportion of direct and diffused reflection therefrom.

In the concluding section of his address Mr. Masterman again emphasised that the specification can be a good servant but a bad master. A large degree of responsibility for detailed planning is necessarily left in the hands of those using it. The written word in the form of a standard specification can never supersede the competent lighting engineer.

Mr. A. E. Jepson, who presided, thanked Mr. Masterman for his excellent address.

Mr. Sawyer said that he was impressed by Mr. Masterman's clear exposition of the specification. The adoption of correct spacing and height would go far towards attaining uniform brightness. Originally there was a tendency to accentuate light at the mid-span point by means of directive appliances, but now it was more usual to aim at more uniform distribution.

Mr. Hawkins referred to the problem of lighting arterial roads, such as the West Lancashire road, where several authorities were responsible for the lighting.

Mr. Haines referred to the impression that a high diversity factor was sometimes responsible for better visibility. He thought, however, that there were advantages in close spacing of small units.

Mr. Ballard remarked on the curious fact that a portion of road receiving the highest illumination appeared to a motorist to be in shadow. The drawback to "patchy" lighting was that the eye was apt to be overworked by the effort at adjustment to the constant changes. It was desirable that the factor of road-brightness should be introduced into the next specification.

Mr. H. E. Chancellor likewise referred to the merits of closely spaced small units, especially when there were bends and curves. Objects required vertical as well as horizontal illumination.

Mr. A. L. Holton emphasised the importance of public lighting being in the hands of definitely trained competent lighting engineers—such as few towns at present possessed. He alluded to the classification of roads in terms of traffic, and asked whether the lighting of residential roads should be sacrificed for the sake of those carrying heavy traffic—if so the lighting should be reduced in steps.

Alderman Williams (chairman, Manchester Public Lighting Committee) agreed as to the importance of competent public lighting engineers. Local Authorities were often blamed for conditions of public lighting that were due to inability to afford something better.

Mr. J. Sellars enquired as to the grading of lighting in connection with accident statistics. His own preference was for staggered side suspension, though central suspension might be valuable in marking the line of a road. "Diversity of Brightness" and "Diversity of Illumination" should be regarded as definitely distinct things which might not be equally easy to attain.

Mr. A. E. Jepson remarked that fittings constituted a very small portion of the cost of an installation. With central suspension, directional fittings were at a disadvantage.

Mr. Masterman, in reply, agreed that the case of the arterial road passing through areas served by several authorities deserved consideration. He had assumed an installation costing £400 per mile as one that would render headlights unnecessary. The capital charges, maintenance, and energy would amount to approximately £5 per yard per annum. Central suspension was probably the best arrangement where only traffic on the road had to be considered. Average illumination was evidently difficult to obtain and measure, and road brightness was a difficult item to specify at present.

Glyndebourne Festival Opera House

Visit of Members of the Illuminating Engineering Society on April 16th, 1935

The visit of the Illuminating Engineering Society, by invitation of Mr. John Christie, to Glyndebourne Festival Opera House, near Lewes, was of rather an unusual nature, and proved to be a very interesting occasion. About 30 members took part, the majority availing themselves of the special arrangements made by the Southern Railway which ensured an easy journey. Glyndebourne nestles snugly in the hollow of the Sussex Downs and in the grounds of his beautiful old-world house Mr. Christie has constructed the Festival Opera House which has created great interest in the musical world, and which members of the Society found equally interesting from the technical point of view.

The party were received by Mrs. Christie and entertained to tea with charming informality in the music room—a lofty hall with an organ built in one end and a pleasing arrangement of concealed lighting, most of the illumination being due to reflection from the domed roof. After tea Mr. Christie led the members out to the delightful terraced lawns where he briefly explained the objects of the Festival Opera House—the presentation of intimate opera on a comparatively small scale, but as perfect as it is possible to make it from the artistic point of view It was also the intention to give ample facility for rehearsal, so that British singers might have an opportunity denied to them in Covent Garden performances. Previous experience had shown that there were many functions to perform besides the arrangement of the opera performances. It was, for example, necessary to provide refreshment facilities for visitors coming from a distance, and furthermore, the artistes engaged (often singers of world-wide reputation) demanded the best possible accommodation in the way of dressing rooms, etc. This has led to the construction of a new quadrangle designed to provide dressing rooms and a green room adjacent to the theatre building, and the party were shown this recent addition as well as the auxiliary premises required for the preparation of scenery, much of which is manufactured on the premises.

On entering the Festival Opera House itself the party were at once impressed with the remarkably fine acoustic properties of the building, and these were put to a severe test by Mr. Christie addressing the audience from the stage in tones hardly above a whisper, which could be readily heard throughout the auditorium. The lighting arrangements were explained in some detail and attention was drawn to an unsual feature of control, viz., the use of variable transformers instead of rheostats for dimming purposes. After listening to the description members had an opportunity of going behind the scenes and inspecting details of the installation, noting also the banks of projectors with colour screens, which take the place of footlights at this theatre. One of the scenes for Mozart's "Magic Flute" was partly set, and Mr. Christie demonstrated some of the beautiful colour-lighting effects which could be obtained, as well as the delicacy of the dimming apparatus.

Before leaving the theatre the president, Mr. Hepworth Thompson, acknowledged the debt which the the Society owed to Mr. Christie, and expressed the warm thanks of the party for their cordial reception.

Mr. Christie's enthusiasm and lavish treatment of his project is reminiscent of the royal patrons of music in the seventeenth and eighteenth centuries. As Mr. Harold Ridge very aptly expressed it, what one obtains at Glyndebourne is not so much grand opera as opera in the grand manner!

This striking picture shows a gas-lighted "keep left" bollard, adjacent to a two-light standard at Northampton, where about 3,000 gas lamps, all now fitted with clockwork control, are in use for street lighting.

Artificial Lighting in the National Gallery

The installation of artificial lighting in the National Gallery, which was officially inaugurated on March 28th, satisfies a need of long standing. It should enable many of those who are occupied during the day to see the pictures in their evening leisure hours.

Showing Appearance of Pictures by Artificial Light.

On Thursday, March 28, an informal reception was arranged at the National Gallery, London, when the new artificial lighting was on view for the first time.

The Right Hon. W. Ormsby-Gore, in opening the new installation, mentioned that the total cost (including all the experimental work prior to the ultimate decision in regard to fittings) has been about £500. He did not, however, consider this an excessive sum, having regard to the world-wide importance of the Gallery and the great increase in its value to the public if the facilities for inspecting the pictures after dark were used to the fullest extent. This led him to emphasise the importance of making known to the public the longer hours of opening thus made possible.

Mr. Ormsby-Gore also drew attention to the very satisfactory effect obtained, the absence of distracting reflections on the front glasses of pictures, and the fact that in many cases (especially on the south walls) there was an actual improvement on the natural lighting: indeed some pictures had never been seen to the best advantage until the new lighting was installed.

The problem of the artificial lighting of the Gallery is, of course, one of long standing. So far back as 1923 a committee was set up to consider the problem. But it was not until 1932 that experiments were commenced. Ultimately the present method, which is based on a scheme submitted by the General Electric Co., Ltd., was adopted. The main feature of the scheme is the provision of a high and even illumination on all the picture walls, whilst the arches of the galleries are relatively dimly lighted. Attention is thus automatically concentrated on the pictures, and the familiar difficulty of reflection of light from the glazing of pictures has been almost completely overcome, a result of the distribution of illumination and the fact that surroundings, the upper parts of the walls and the observers are in partial shadow.

In all a total of sixty-four fittings have been installed, including those on the stairs and in the vestibule. In most cases 1,500-watt lamps are used, but some of smaller sizes are used in the smaller rooms. The total lighting load is 90 kw. The lantern is in the form of an inverted pyramid. It contains a single high-power frosted lamp and one or more mirror glass reflectors of special contour, designed to secure even illumination on the walls where the pictures are displayed (i.e. by accentuating the intensity in the direction of the lower and more remote parts).

The light-source is screened from view by a series of metal louvres, and the contiguous sides of the lantern are closed. The placing of the fittings at an unusually high level prevents their reflections being visible in the glazing unless the pictures are approached very closely. A stand-by battery, which would maintain some lighting in the event of a temporary failure of the electricity supply, has been installed.

A View of a Section of the National Gallery showing the special lighting fittings employed.

Literature on Lighting

(Abstracts of Recent Articles on Illumination and Photometry in the Technical Press)

(Continued from page 123, April, 1935)

I.—RADIATION AND GENERAL PHYSICS.

137. Flame Temperatures.

W. T. David. Nature, 135, pp. 470-471, March 23, 1935.

Gives data indicating reasons for believing that flame temperatures of burning gases as determined by the sodium line reversal method are, in general, far greater than the true flame temperature (mean molecular translational energy. It is inferred that there is little relation between flame temperatures as measured (a) by the sodium line reversal method, and (b) by the platinum resistance method. T. H. H.

II.—PHOTOMETRY.

138. A Visual Photometer for the Measurement of Optical Transmission of the Atmosphere at Ground Level.

F. Löhle. Zeits. für Techn. Physik, 3, pp. 73-76, March, 1935.

The photometer is described with the aid of a diagram and results are presented. W. R. S.

139. Photometric Research and Measurement on the Spectral Intensity of Fluorescing Screens, with Particular Reference to those irradiated by Electrons.

M. von Ardenne. Zeits. für Techn. Physik, 3, pp. 61-67, March, 1935.

Describes methods of making such measurements and gives results. Photographs are presented. W. R. S.

140. A Photographic Moonlight Recorder.

C. B. Williams and G. A. Emery. J. Sci. Inst., 111, April, 1935.

This moonlight recorder consists of a cylindrical lens mounted on a light-tight drum, rotating at a speed of one revolution in 24 hours 50 minutes. The axis of the drum points to the pole star, and by means of a timing disc the drum is set so that the lens follows the position of the moon. Inside the rotating drum is fixed a drum carrying photographic paper on which a line image of the moon is produced. The darkening of the photographic paper indicates the intensity and duration of the moonlight. S. E.

141. A Green Monochromatic Filter.

B. Lyot. Comptes Rendus, 200, No. 9, pp. 738-739, February 25, 1935.

Describes a method of obtaining an approximately monochromatic green filter by combining a Schott V.G.3 glass with either a glass impregnated with neodymium or a glass cell containing a saturated solution of neodymium nitrate. Curves are given illustrating the variation of transmission, with wave-length. The filters may be of use in the comparison of luminous sources with widely differing temperatures. L. J. C.

142. The Photometric Study of Microbe Multiplication.

M. Faguet. Comptes Rendus, 200, No. 6, pp. 498-500, February 4, 1935.

Describes a photometric method of studying the growth of a microbe culture by measurement of the amount of light diffused by the culture, upon which a beam of red light is focused. The measurement is effected by comparing the amount of light diffused by the culture on to a photo-electric cell with that directly incident on the cell when this occupies the position of culture. L. J. C.

III.—SOURCES OF LIGHT.

143. Notes on the Chemical Spectro-analysis of Luminous Discharge Tubes, and particularly those with an Inert Gas and Mercury Vapour Filling.

H. Shober. Zeits. für Techn. Physik, 3, pp. 67-73, March, 1935.

The method and results are described in detail, with photographs. W. R. S.

144. A Source of Light of Exceptional Intensity and Very Short Duration.

A. Michel-Levy and H. Muraour. Comptes Rendus, 200, No. 7, pp. 543-545, February 11, 1935.

The luminosity which accompanies the detonation of an explosive mixture is greatly influenced by the nature of the ambient gas. The authors describe a method of obtaining a flash of exceptional intensity and extremely short duration by exploding a mixture of tetranitromethane and toluene in an atmosphere of argon. The flash has a duration of less than five-millionths of a second, and produces a continuous spectrum of high intensity extending well into the ultra-violet. L. J. C.

145. A New Powerful Glow-Discharge Tube for the Spectroscopic Investigation of Small Quantities of Substances.

H. Schüler and H. Sollow. Zeits. f. Phys., 93, pp. 611-619, 1935.

A light source is here described which, in addition to the property of earlier constructed tubes of emitting sharp spectral lines, possesses also the property of needing only very small quantities of substances for producing a strong excitation of the spectra and of being indifferent to the manner in which the substance in question is chemically combined. Moreover, this arrangement allows these substances to be recovered after the experiment in a convenient manner, and almost without residue. This source of light has already been used for researches into the hyperfine spectra of Protoactenium, Cassiopeium (Lutecium), Terbium, Samarium, Scandium, Thulium, Yttrium, Rhodium, Holmium, and Europium. The lamp here described opens the way to investigations with still smaller quantities of substances when merely ordinary spectrum photographs are needed instead of those showing hyperfine structures of the spectra. Such experiments with this tube might be used to prove the existence of new elements produced through nuclear changes. They might also enable, in favourable cases, conclusions to be drawn on the mechanical moments of the unstable atomic nuclei of artificially produced radioactive substances. T. H. H.

146. A New Gas Mantle.

Gas World. March 23.

A brief description of a new gas mantle suitable for certain flood-lighting effects. J. G. C.

147. A New Street Lamp.

Gas Times. April 6.

An illustrated description of a new street lamp

reflector for use with gas lamps. There is also an illustrated description of a new gas lighting unit suitable for window and showroom display lighting. J. G. C.

IV.—LIGHTING EQUIPMENT.

148. Report of the Joint Committee on Illuminating Glasses.

Anon. Glass Industry, 16, p. 18, 1935.

This Joint Committee consists of representatives of the Illuminating Engineering Society (U.S.A.), the Glass Division of the American Ceramic Society, and the Illuminating Glassware Guild. General conceptions of light-diffusing glasses and representative types are discussed. Definitions are given covering most of the types used in illuminating fittings, including, among others, opal, opalescent, alabaster, cased, matt surface, etc. S.E.

149. A new Sign with Moving Radial Rays.

Anon. Das Licht, 61, March, 1935.

The radial rays are produced by projecting the beam from a searchlight on to a many-sided pyramid composed of triangular plates of mirror glass. Each plate, being flat, produces a sharply defined beam. By rotating the pyramid on its axis and playing the searchlight only on the upper half, the rays are made to rotate. S. E.

150. A Modern Sign.

J. Guanter. Das Licht, March, 1935.

The background of the sign consists of horizontal louvres in the form of inverted troughs. It is illuminated from the back, the light being reflected twice from the faces of the angled louvres. The lettering of the sign is mounted on the front of this illuminated panel, and is therefore seen in silhouette. S. E.

V.—APPLICATIONS OF LIGHT.

151. Some Visibility Tests on Lighted and Unlighted Highways.

P. Moon and R. C. Warring. Frank. Inst. J., 219, pp. 285-314, March, 1935.

The paper discusses results of 5,000 tests to determine the effect of various factors on the distance at which the driver of a motor vehicle can see a pedestrian. Some very interesting conclusions are drawn from the data obtained. S. S. B.

152. The Economics of Good Street Lighting.

G. F. Mudgett. World Power, 23, p. 168, April, 1935.

A brief reference is made to a paper read before the Association of Municipal Utilities on street lighting in the Province of Ontario. A definite relationship is drawn between accidents and inadequate street lighting. C. A. M.

153. Lighting of the National Gallery.

Anon. Elect., 114, pp. 448-449, April 5, 1935; World Power, 23, p. 187, April, 1935.

Descriptions are given, with photographs, of the new lighting equipment at the National Gallery. Very successful results are said to have been obtained. The total lighting load is 90 kw. C. A. M.

154. The Art of Correct, Yet Beautiful, Lighting.

N. D. Rayner. El. Times, 87, p. 345, March 7, 1935.

A description, with several photographs, of suitable lighting for domestic use. W. R. S.

155. Jubilee Illuminations.

Anon. El. Times, 87, p. 443, March 28, 1935.

Gives a further selection of fittings, chiefly decorative, appropriate to the Jubilee celebrations. W. R. S.

156. Jubilee Lighting with Gas.

Gas World, March 30; *Gas Journal,* March 27; *Gas Times,* March 30.

An illustrated description of a gas decorative device to be used in connection with the Jubilee celebrations. J. G. C.

VI.—MISCELLANEOUS.

157. The Measurement of Visual Acuity by Means of Interference Fringes.

Y. Le Grand. Comptes Rendus, 200, No. 6, pp. 490-491, February 4, 1935.

Describes a method of comparing, by means of interference fringes, the separating power of the retina with the visual acuity of the whole eye. It is shown that sharpness of vision is dependent upon the structure of the retina in the case of objects which are strongly illuminated or highly contrasted. In all other cases it is limited by the optical properties of the whole eye. L. J. C.

158. The Disadvantages of Spectacle Lenses Containing Didymium.

A. Polack. Comptes Rendus, 200, No. 6, pp. 488-490, February 4, 1935.

Examines the hypotheses put forward to explain distinct vision, and discusses the evidence in favour of the Newtonian hypothesis that the retinal image is formed in that region of the retina on which the yellow radiation is concentrated, and that sharpness of vision is greatest for the yellow radiation. On this hypothesis the use of didymium in spectacle lenses is definitely detrimental, since didymium absorbs the yellow radiation. L. J. C.

159. Artificial Light in Photography.

O. Reeb. Das Licht, 54, March, 1935.

A method of determining the sensitivity of various types of photographic emulsions to light throughout the spectrum is described. The spectral sensitivity curves of blue sensitive and panchromatic films are reproduced. The effect of metal filament, arc, and discharge lamps on various kinds of film was measured by determining the times necessary to produce equal blackening. The high pressure mercury lamp was the most rapid in action with blue sensitive, orthochromatic and panchromatic films. S. E.

160. The Standardisation of Lovibond Red Glasses in Combination with Lovibond Yellow.

K. S. Gibson and G. W. Haupt. J. Res. Nat. Bur. Standards, 13, 433, 1934.

Over 2,300 Lovibond glasses have been tested for renumbering. They were compared with a series of twenty standard glasses, for which a series of numbers had been determined by spectrophotometric measurements. S. E.

161. Three-colour, One-exposure Camera.

Nature, 135. p. 479, March 23, 1935.

Such cameras can now be purchased. These make use of the following method: Light from the lens strikes a semi-reflecting plane mirror, and a portion of it is deflected to form an image on one of the photographic plates placed behind its suitable colour-filter; the remainder of the light passes through to meet a second semi-reflecting mirror, which deflects a portion on to another plate, while the remainder passes through to the back of the camera, where the third filter and plate are situated. T. H. H.

162. Nature of Lightning Discharges.

H. Norinder. Nature, 135, p. 477, March 23, 1935.

A lightning flash consists of a series of partial discharges of durations up to 200 micro-seconds. These are of a quasi-oscillatory nature of period about 60 micro-seconds, with superimposed variations of a duration of 1 or 2 micro-seconds. T. H. H.

Public Lighting in Leicester

The Annual Report of the Public Lighting Engineer for Leicester, Mr. Thomas Wilkie, reveals conditions that have not altered greatly during the past year. The lighting rate shows a slight fall, from 5.51d. to 5.45d. per £, and the progressive increase in the number of lamps in use, especially electric lamps, continues.

Recent Patents

(Abstracts of recent Patents on Illumination & Photometry.)

No. 423,536. "Anti-Dazzle Device For Lamps."
Taylor, F., November 24, 1933.

The specification describes an anti-dazzle device comprising a ring carrying a number of spaced vertical vanes and a horizontal vane extending above the bulb of the lamp with which the device is to be used and having its rear edge substantially conforming to the curvature of the reflector of the lamp.

No. 423,989. "Improvements in Installations comprising One or More Electric Discharge Tubes Having a Vapour Filling."
N. V. Philips, Gloeilampenfabrieken, September 29, 1933 (*Convention, Germany.*)

According to this specification, a system supplying vapour filled discharge tubes is provided with a temperature operated control which, when the ambient temperature falls, raises the supply voltage or reduces the impedence in circuit, and, when the ambient temperature rises, reduces the supply voltage or increases the impedence in circuit.

No. 424,203. "Improvements in and Relating to Gaseous Electric Discharge Lamps."
The British Thomson-Houston Company, Limited, Davies, L. J., and Scott, W. J., August 15, 1933.

This specification suggests the inclusion within the envelope of a high pressure arc discharge lamp of powdered refractory material, such as tungsten, in such a fine state of sub-division that it is capable of being picked up by the convection currents produced in the gas by the arc and thus conveyed to the arc stream.

No. 424,600. "Improvements in or Relating to Directional Lighting Fittings."
The General Electric Company, Limited, and Beggs, S. S., February 15, 1934.

This specification relates to fittings having reflectors for distributing the light from a vertical linear source in preferred directions. According to the specification the fitting comprises a diffusing surface surrounding the lower part of the source, which surface substantially increases the illumination below the source, but leaves unaffected the light intensity in that preferred direction in which it is a maximum. The diffusing surface may be of substantially conical shape with its apex downwards and its upper portion may be clear. Reflectors are shown associated with the upper portion.

No. 424,667. "Improvements in or Relating to Automobile Headlights."
Wheatley, C. W. C., January 15, 1934.

This specification relates to head-lamps which swivel with the steering wheels of a vehicle. According thereto an electro-magnetic device is associated with the head-lamp and is adapted to be increasingly displaced with increasing actuating current. The displacement may be resisted by a spring. Two headlights may be arranged to swivel in opposite directions. The actuating current may be controlled by a variable resistance operated by the steering mechanism.

No. 424,705. "Improvements in Illuminated Signs."
Claude-General Neon Lights, Limited, and Archibald, L. A., November 7, 1933.

This case covers an illuminated sign comprising a number of tubular light sources arranged parallel with one another, and screens carried upon the light sources and disposed in relation one with another so that devices or legends are formed either by the association of the neighbouring exposed portions of the light sources or by associatio nof the neighbouring screens, the screens being removable so that the arrangement may be varied to alter the form of the device or legend exhibited. The screens may be opaque to block the light from the sources, or they may be translucent and coloured. The light sources are preferably luminous discharge tubes.

No. 424,802. "Improvements in or relating to Light-controlled Devices or Apparatus."
Dorn, J., Duite, E. D., and Gore, A., December 23, 1933.

This specification describes a light-controlled device in which the quantity or intensity of light acting upon a light-sensitive substance or photo-electric cell is modulated by means of a moving element of translucent material so formed as to vary in thickness from point to point. The invention is illustrated as applied to an engraving or milling machine in which a primary replica or counterpart is used as a guide to control the forming tool. The replica is formed of paraffin wax and is mounted upon the machine table to be traversed in relation to a pencil of light passing from a source through the replica to a photo-electric cell, in the same manner as the work is traversed in relation to the forming tool. The forming tool is moved in the third dimension in accordance with the photo-electric current of the photo cell, so that the work is formed as a three-dimensional reproduction of the replica.

No. 424,818. "Improvements in or relating to Electric Lighting Installations."
N. V. Philips, Gloeilampenfabrieken, September 13, 1933 (*Convention, Germany*). *Addition to No.* 389,025.

This specification describes an installation comprising gas-filled incandescent cathode discharge tubes operated by means of transformers having their primary or feed circuits in series in accordance with the Parent Specification No. 389,025 in which the tubes are three-phase, built up of three limbs merging into one another at one end, electrodes being arranged at the free end of each limb to give a star-connected tube. The electrodes may be connected to either star- or delta-connected secondary windings of three-phase transformers, the primaries of which are connected in series in the three phases of the supply.

No. 424,904. "Improvements relating to Headlamps of Vehicles."
Metropolitan-Cammell Carriage, Wagon and Finance Company, Limited, and Green, H., October 21, 1933.

According to this specification a vehicle headlamp has a number of translucent strips mounted within the lamp casing and in front of the lamp in a rectangular frame and operating means are provided so that the strips may be swung from a position parallel to the issuing beam to one nearly normal thereto to form a screen.

Jubilee Illuminations

Some further notes on Floodlighting to be initiated on May 6th.

Somewhat fuller data in regard to the Jubilee Floodlighting, on which a note appeared in our last issue, are now available. It would seem that practically all the buildings in London illuminated in 1931 will be floodlighted again, and many more; whilst in provincial cities the display will be on a vastly greater scale than ever before.

Floodlighting in London.

Amongst the national public buildings in London that are expected to be illuminated are: Westminster Abbey and St. Paul's, Buckingham Palace, St. James's Palace, and the Victoria Memorial, the Admiralty Arch and the Horse Guards, the Foreign Office and the Board of Trade, the Tower of London and the Tower Bridge, Somerset House, and the National Gallery. Amongst other leading buildings may be mentioned: The Mansion House, the Guildhall, the Bank of England, Dominion Building, Canada House, and South Africa House; and amongst professional buildings those of the Institution of Electrical Engineers, and of the Incorporated Society of Accountants, St. Paul's Station, the top of the Monument, the Old Bailey (figure of Justice), Unilever House, the Shell Mex building, and the Ritz, Savoy, and Dorchester Hotels.

H.M.S. President in the Thames is to be again illuminated, and the floodlighting of St. James's Park by gas will again be a leading feature.

Electric Floodlighting in Provincial Cities.

Amongst electrical lighting efforts in other cities we notice Edinburgh Castle (almost unique for its outstanding site) and the National and Scott Monuments; the Tower of St. Giles's, and the University buildings in the same city. In Glasgow, similarly, the Kelvin Hall, the City Chambers, and the Art Gallery are among the buildings to be floodlighted; in Belfast the Royal Courts of Justice, the Houses of Parliament, and the City Hall.

Other instances of electric lighting, picked out almost at random from the long lists now available, are:—

Birmingham—Parish Church of St. Martin, Cathedral Church, Town Hall, etc.
Bolton—Town Hall and Market Place, War Memorial, etc.
Bristol—Town Hall, University Tower, Cathedral, and St. Mary's Redcliffe.
Durham—The Cathedral and Castle.
Leeds—Kirkstall Abbey.
Liverpool—Town Hall, Municipal Buildings, etc.
Newcastle-on-Tyne—Abbey and St. Mary's Church, etc.
Salisbury—The Cathedral.
Sheffield—Town Hall and Cathedral.

At *Bradford, Cardiff, Colwyn Bay, Coventry, Hull, Manchester, Swansea, Warwick,* and many other towns and cities floodlighting is already being arranged. A feature in many cases is the illumination of historic buildings, which make excellent subjects, such as Warwick Castle, and the illumination of river approaches, parks, gardens, etc., such as those at *Bath, Morecambe, Ilford,* and at many seaside towns (*Blackpool. Dover. Eastbourne, Minehead, Worthing,* etc.).

We have also been favoured by the following list of towns and cities where floodlighting with gas is being installed:—

Instances of Gas Lighting.

Wolverhampton—The Roman Catholic Church; 10 lamps will be used.
Carmarthen—The Picton Monument by 2 10-light and 2 3-light floodlighting projectors.
Warwick—Two lamps will be used to assist in the illumination of Warwick Castle.
Burton-on-Trent—32 10-light lamps will be used on three displays. 14 in the illumination of the Parish Church, 12 on St. Paul's Church, 6 on the Tutbury Castle ruins.
Rhyl—The Promenade Gardens; 31 lamps.
Chester—The Castle.
Colne—The Library and Public Hall.
Cockermouth—The Town Hall.
Rochdale—The Museum.
Stoke-on-Trent—The Town Hall, Longton Town Hall, and Trentham Parish Church.
York—The North Face of York Minster and the Chapter House, the Minster Library, a portion of the City Walls and the Treasurer's House.
Exeter—Part of the University College of the South West.
Newcastle-on-Tyne—The Hancock Museum.
Plymouth—The Gardens, Devonport Park.
Leeds—The Mansion at Templenewsam.
Stretford—The Town Hall and Urmston Public Baths.

In addition the War Memorials or Churches will be illuminated by gas in the following towns, amongst others: *Lincoln, Droitwich, Leek, Gloucester, Batley, Perth, Accrington,* and *Melrose.*

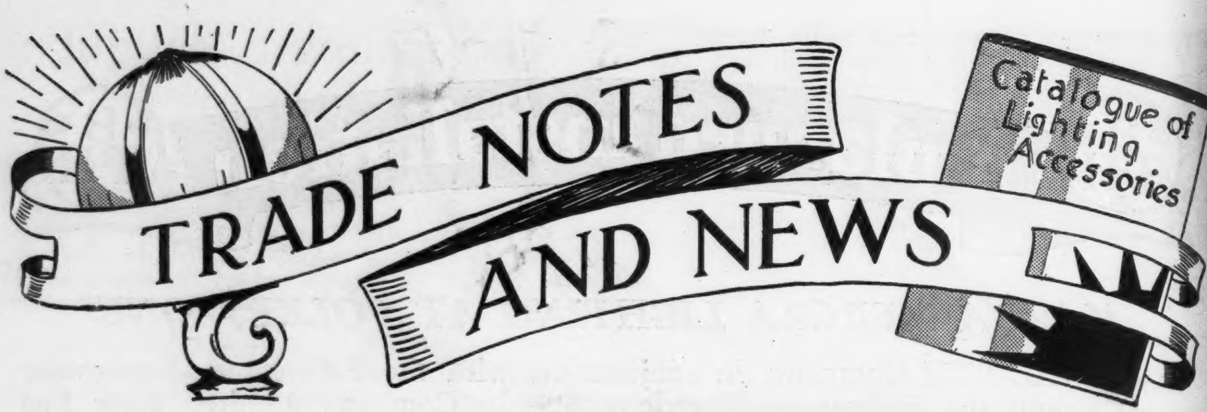
It should, of course, be clearly understood that the above lists are not in any sense exhaustive.

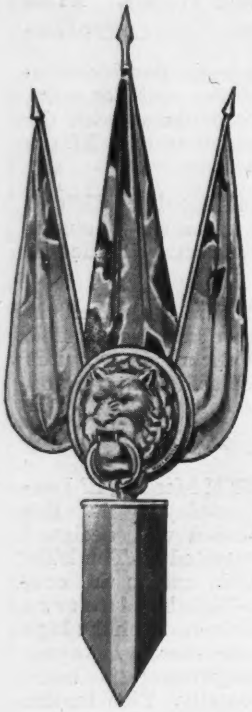
Floodlighting with gas and electricity will, in most cases, be maintained for some weeks after May 6, so that everyone will have a good chance of seeing what is being done. Traffic in London is also being suspended in certain streets, for the benefit of crowds of sightseers.

The "Murray" Car on the South Australian Railway

We reproduce below a view of the interior of the "Murray" Car on the South Australian Railway, which was used by H.R.H. the Duke of Gloucester during his recent tour. The car, which was origin-

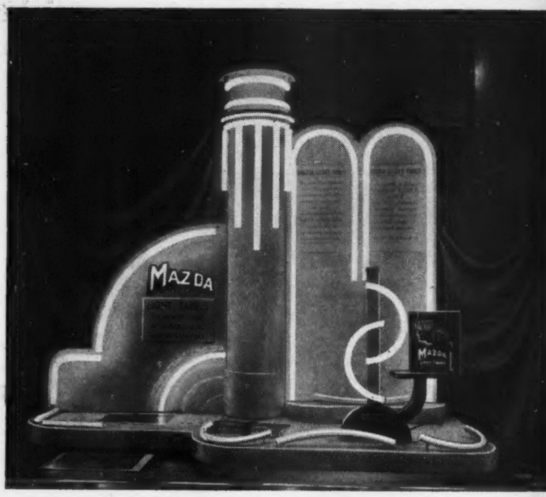
ally built for the Commissioner of Railways to use for inspection purposes, is panelled in Blackwood and Queensland maple, and is provided with special steel girders, as a protection against telescoping in the event of collision. The lighting consists of two Holophane "Ripple-Lite" units, housing 60 and 40 watt lamps respectively, which are operated on a 32-volt system. Adjoining the lounge are three sleeping compartments, one having a beautifully appointed bathroom. Holophane "Residential" units are mounted, one on either side of the mirror and in the sleeping compartment, whilst in the dining room eight "Ripple-Lite" units in all are installed.





Hailware Jubilee Units

We illustrate herewith two more Hailware units specially designed for the Royal Jubilee Celebrations. Numerous other attractive designs figure in a list (HW/50/4) just published.



A Multi-Coloured display of Mazda Light Tubes in the window of the Sun Electrical Company, Ltd.; these tubular lamps are proving increasingly popular for novel window displays.

The Mazda Message

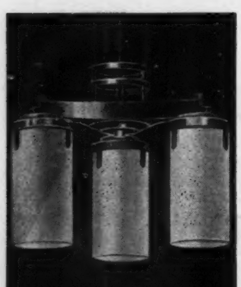
As we go to press we receive the first issue of the above publication which contains plenty of interesting matter attractively illustrated. Reference is made to the new Mazda Mercra Lighting in Birmingham, the new Light Tubes (illustrated above), Jubilee Illuminations, and the Manufacture of Glass for Lamps. The familiar Mazda dancing girl appears on the front cover.

The King's House

We are informed that the Edison Swan Electric Co., Ltd., who hold royal warrants for electric lamps, have been privileged to supply lamps and cable for the house which the royal warrant holders are presenting to the King in commemoration of his twenty-five years' reign.

Osira Colour-Floodlighting

Another recently issued G.E.C. leaflet (F. 7151) on the above subject is most effectively illustrated in colour. Buckfast Abbey, Warren Street Station, and the Garrick Theatre, Southport, are amongst the installations thus portrayed. Technical details of units are also presented.



A pleasing 3-light fitting: special lowering device for removal of diffusing glass cylinders.

Euston Fittings

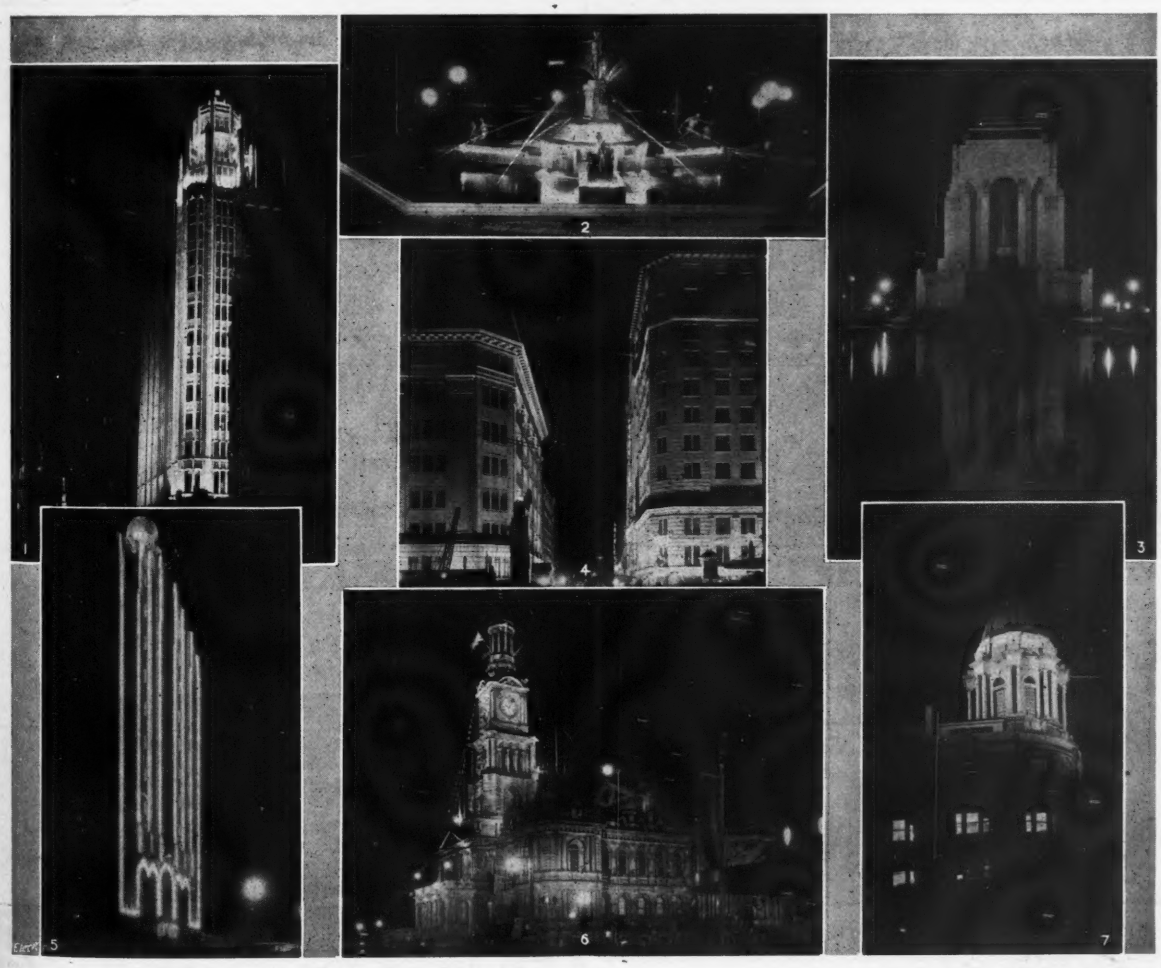
The adjacent three fittings are typical of many which figure in the 1935 catalogue of the Euston Manufacturing Co., Ltd. Each of the three strikes a distinctive note, but the "Business Standard" and the novel pendant shown on the right are perhaps especially effective.

A "Business Standard" to take two 40/60 w. lamps with separate pushes in base.

A Novel Pendant with disc deflector above diffusing glass globe.

This pleasing picture shows the use of twenty 10-light alignment gas lamps to flood-light a border in gardens at Okehampton. In such cases diffused lighting, giving a "soft" effect, is what is chiefly needed.

By the courtesy of the "Electrical Review" we reproduce below some night views of Sydney, N.S.W., illuminated on the occasion of the recent visit of the Duke of Gloucester. The lighting is of interest as an indication of what may be expected in connection with the Jubilee in May. In most cases floodlighting on familiar lines is provided, but a somewhat unusual effect, in which luminous lines play a leading part, is achieved on the exterior of the Newspaper Building.



[By courtesy of "The Electrical Review."

Sydney, N.S.W., Illuminated for the Duke of Gloucester's Visit

1. Grace Building, York and King Street. 2. Archibald Memorial Fountain, Hyde Park. 3. Anzac Memorial, Hyde Park. 4. Farmer's and Gowing Bros. emporiums, George and Market Streets. 5. The Sun Newspaper Building, Elizabeth Street. 6. Town Hall. 7. The "Sydney Morning Herald" building, Hunter Street.

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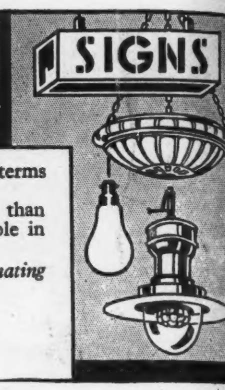
A DIRECTORY OF LIGHTING EQUIPMENT



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"Lux" is the only French journal which specialises in all aspects of lighting; it is the official organ of the Association Francaise des Ingenieurs de l' Eclairage (equivalent to the Illuminating Engineering Society in France).

It furnishes a complete record of interesting developments in lighting in France and on the Continent. It is fully illustrated and in particular devotes a considerable number of its pages to Decorative Lighting.

By studying these articles and the numerous photographic reproductions of modern lighting installations the reader can readily gain an excellent impression of French methods and practice in matters of Illumination.

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